Intelligent Transportation Systems

*Selected Broadcast & Cellular Systems for Transportation*

Prof. Dr. Thomas Strang
Outline

- Classification Scheme
- Exemplary Broadcast Services for Transportation
  - Radio Data System (RDS)
    - RDS-TMC
    - DGPS via RDS
  - Transport Protocol Experts Group (TPEG)
- Exemplary Cellular Services for Transportation
  - eCall
Wireless Interconnections
Networking types

Broadcast
+ Scalability
+ Range
− Delay
− Individuality

Cellular
− Scalability
− Range
+ Delay
+ Individuality

Ad-hoc
− Scalability
− Range
+ Delay
+ Individuality
Wireless Interconnections
Broadcast

Why broadcast?
- Long range: several hundreds of kilometers possible
- Good scalability: usable with millions of receivers

Broadcast is superior to other technologies to distribute information that
- is relevant for a large number of users,
- is invariant for a longer time period,
- comprises large amount of data

Disadvantages of broadcast:
- Unidirectional (can be complemented by cellular communication)
- Long delays
- Less appropriate to distribute individualized information
Radio Data System (RDS)
Introduction to RDS

- RDS has been developed in the 80’s as European successor of the German “Autofahrer Rundfunk Information (ARI)” system
  - ARI: AM-signal at 57 kHz subcarrier to indicate announcement on air introduced by Bosch/Blaupunkt in 1974
  - Requirements for RDS included backward-compatibility to ARI
- First RDS receivers presented at IFA’87 in Berlin
- Standardized as CENELEC EN 50067 and IEC 62106
- Hierarchical low-bitrate digital data service for FM radio:
  Structured datastream of 673 payload bit/s divided in 11.4 data groups per second added to an FM transmitted radiosignal (87.5 MHz–108 MHz)
RDS Applications

Five most important applications („basic RDS features“):

- **Programme Identification (PI)**: 16-bit code containing country symbol, regional code, and number permitting identification of broadcaster and particular programme

- **Programme Service (PS) name**: 8 alphanumeric case-sensitive chars

- **Alternative Frequency (AF) lists**: One or more lists, each of up to 25 frequencies (as channel numbers) of transmitters of the same programme

- **Traffic Programme (TP) flag**: Set if programme provides traffic announcements from time to time

- **Traffic Announcement (TA) flag**: Set during announcement to enable volume adjustments etc.

- All 5 are implemented everywhere and intended primarily to be used in mobile reception mode with car radios with automated tuning functions
RDS Applications (Cont‘d)

- **Decoder Information (DI)**: Indicates one of a number of operating modes for the receiver (e.g. mono, stereo)
- **Music Speech (MS) flag**: Indication whether music or speech is sent
- **Programme Type (PTY)**: One of 31 different identifiers to specify the current programme type (e.g. news, sport, pop music etc.)
- **Programme Item Number (PIN)**: Code identifying a particular programme by start time and date to enable automatic on/off switching of receivers
- **Radio Text (RT)**: 32 or 64 characters of text for display by receivers
- **Radio Paging (RP)**: Paging function known from beepers via RDS
- **Emergency Warning System (EWS)**: A feature using a very small amount of data for emergency warning services such as national disasters and hazardous chemical spills.
Excurse: Disaster Management Cycle

**Pre-Disaster**

- **Preparation**
  - Organisation
  - Resource planning
  - Deployment planning
  - Insurance

- **Prevention**
  - Land use planning
  - Technical measures
  - Biological measures

- **Event analysis**
  - Reducing vulnerability

- **Assessing hazards and risks**
  - Preparedness

**Intervention**

- **Warning**
- **Information**

- **Response**

- **Reconstruction**
  - Definitive repair
  - Reconstruction
  - Strengthening of resilience
  - Financing

**Post-Disaster**

- **Limiting extent of damage**

- **Recondition**
  - Provisional repair
  - Supply and disposal
  - Transport systems
  - Communications
  - Financing
  - Emergency legislation

**Image:** PLANAT, Bundesamt für Umwelt, Schweiz

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft
RDS Applications (Cont‘d)

- Clock Time and date (CT): Reference time
- Enhanced Other Networks (EON) information: cross-reference to other broadcast services including PI and AF for quick retuning, as well as TP, TA, PTY and PIN of these services
- In-House (IH): Data channel for use only by broadcaster
- Transparent Data Channel (TDC): Provides for a continuous data stream to receivers and associated peripherals (e.g. printer)
- Open Data Application (ODA): Universal generic service which permits new applications to be designed and implemented in still available data groups, e.g. DGPS messages or control of variable message signs
- Traffic Message Channel (TMC): Popular adoption of the ODA to transmit Traffic and Travel Information (TTI) messages
Multiplex-Spectrum of Baseband Signal

RDS sub-carrier 57 kHz ± 2.5 kHz

Baseband Coding Structure

Group = 4 blocks = 104 bits

Block 1  Block 2  Block 3  Block 4

Block = 26 bits

Information word  Checkword + offset word

Information word = 16 bits

Checkword = 10 bits

Error Protection and Correction

- Each transmitted 26-bit block does contain a 10 bit CRC derived with the generator polynomial

\[ G(x) = x^{10} + x^8 + x^7 + x^5 + x^4 + x^3 + 1 \]

- The resulting code has the following error-checking capabilities:
  - Correct all single and double bit errors in block
  - Detects 100% error bursts spanning \( \leq 10 \) bits, 99.8% of bursts spanning 11 bits, and about 99.9% of any longer bursts
  - The code is able to correct any single burst of a span of 5 or less bits
Flywheel Synchronization Mechanism

- Data transmission is fully synchronous, and there are no gaps between the groups or blocks.
- Before transmission, the CRC checksum is subject to addition (mod 2) of an error-protecting characteristic preserving, block specific offset according to:

<table>
<thead>
<tr>
<th>Block</th>
<th>10-bit Offset Words added to CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0011 1111 00</td>
</tr>
<tr>
<td>B</td>
<td>0110 0110 00</td>
</tr>
<tr>
<td>C, for type A groups</td>
<td>0101 1010 00</td>
</tr>
<tr>
<td>C, for type B groups</td>
<td>1101 0100 00</td>
</tr>
<tr>
<td>D</td>
<td>0110 1101 00</td>
</tr>
</tbody>
</table>

- The purpose of adding the offset word is to provide a group and block synchronisation system in the receiver/decoder ("flywheel sync")
Message Format

- Messages normally occupy same fixed positions within a group
- First block always contains PI code
- PTY and TP flags always in group 2

A total of four type 0A groups are required to transmit entire PS name

Obviously, data is broadcasted in “chunks” and must be accumulated at receiver – this is a major design criteria to overcome the challenging transmission channel
Alternative Frequency (AF) Encoding

- **Purpose:** Facilitate the automatic tuning.
- **Two list encoding methods:**
  - Method-A (≤ 25 alternatives): main transmitter + alternatives list
  - Method-B (> 25 alternatives): pairs of main transmitter + alternative

<table>
<thead>
<tr>
<th>Number</th>
<th>Binary Code</th>
<th>Carrier Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0000 0000</td>
<td>Not to be used</td>
</tr>
<tr>
<td>1</td>
<td>0000 0001</td>
<td>87.6 MHz</td>
</tr>
<tr>
<td>2</td>
<td>0000 0010</td>
<td>87.7 MHz</td>
</tr>
<tr>
<td>..</td>
<td>..</td>
<td>..</td>
</tr>
<tr>
<td>204</td>
<td>1100 1100</td>
<td>107.9 MHz</td>
</tr>
<tr>
<td>205</td>
<td>1100 1101</td>
<td>Filler Code for uneven #</td>
</tr>
<tr>
<td>206..255</td>
<td>Special Meaning Codes</td>
<td></td>
</tr>
</tbody>
</table>
Required Data Repetition Rates

- There is no fixed rhythm of repetition of the various types of group; that is, there is ample flexibility to interleave the various kinds of messages to suit the needs.

<table>
<thead>
<tr>
<th>Group types</th>
<th>Features</th>
<th>Typical proportion of groups of this type transmitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A or 0B</td>
<td>PI, PS, PTY, TP, AF, TA, DI, MS</td>
<td>40% (i.e. 4x 0A/s)</td>
</tr>
<tr>
<td>1A or 1B</td>
<td>PI, PTY, TP, PIN</td>
<td>10%</td>
</tr>
<tr>
<td>2A or 2B</td>
<td>PI, PTY, TP, RT</td>
<td>15%</td>
</tr>
<tr>
<td>14A or 14B</td>
<td>PI, PTY, TP, EON</td>
<td>10%</td>
</tr>
<tr>
<td>Any other</td>
<td>Other applications</td>
<td>25%</td>
</tr>
</tbody>
</table>

- Example Austria: ORF broadcasts RDS-TMC with up to 3 groups/s

[Source: ResearchAndMarkets]
Traffic Message Channel (TMC)

- Objective: broadcast Traffic and Travel Information (TTI) messages
- Language independent digitally coded
- Receivers must be enabled to filter only relevant messages
- Given the capacity of RDS, a maximum of about 300 TMC messages/h!
- Used to assist in dynamic route planning
- Describing a traffic information event by:
  - Location (+ parameters)
  - Event (+ parameters)
  - Duration & diversion
- Coding at broadcaster-side needed
  - Local location codes (up to only 65,536 only – 16 bit)
  - Universal event codes (up to 2048, currently ~1400)
TMC / ALERT-C messages

No arbitrary locations; instead, lookup in fixed table of locations
Example Message

The message

Motorway A9 Munich-Nuremberg, direction Nuremberg, stationary traffic between exit Pfaffenhofen and motorway interchange Holledau. Deviation recommended via the U31 from exit Pfaffenhofen

would be encoded using the following elements:

- **Duration (DP)**: 0 for no specific duration
- **Diversion (D)**: 1 for deviation being recommended
- **Direction of event (+/-)**: 1 for negative
- **Extend**: 2 for two locations backward in the loc table
- **Event**: 101 for stationary traffic
- **Location Code**: 12735 for motorway interchange Holledau
What does it also mean to have location lookup tables only?

Answer of Ö3 to a question from the audience:

Lieber Ö3-Hörer!

Ö3 strahlt seit 16. Oktober 2002 TMC über die Ö3-Frequenz ab. Um TMC in Österreich empfangen zu können, brauchen Sie die aktuelle Location Code CD (Version 1.0 - Österreich). Haben Sie diese schon?


Bitte setzen Sie sich mit Ihrem Händler in Verbindung - der kann Ihnen die aktuellste L-CD besorgen. Selbstverständlich stehe ich Ihnen für weitere Rückfragen zur Verfügung.

MFG

xxxxxxxxxx
Security in TMC

- The majority of TMC services is provided free-of-charge.
- Some service providers (e.g. private radio companies) sell „better“ quality TMC services (still in the boundaries of the technical capabilities) using an encrypted version of the location table.
- Lack of security mechanism allows crazy things such as the ones described at [http://dev.inversepath.com/rds/cansecwest_2007.pdf](http://dev.inversepath.com/rds/cansecwest_2007.pdf)
Excurse: Global Navigation Satellite Systems (GNSS)

There are several satellite navigation systems with global coverage:

- **GPS**
  - USA; military
  - 2 basic services
- **GLONASS**
  - Russia; military
- **GALILEO (in the future)**
  - Europe;
    - civilian & public regulated
  - 5 basic services:
    - 4 nav + 1 SAR-com
- **COMPASS (in the Future)**
  - China
The determination of the 3 unknowns $X_R, Y_R, Z_R$ requires the reception of the signals of 3 navigation satellites.
Principle of GNSS: Ranging

Problem:
- Receiver has to be synchronised to the satellite’s clocks - which is practically impossible
- Hence, the receiver’s clock is offset with respect to the clocks of the satellites
- A time uncertainty of 1 ns means 30 cm in distance (in 1 μs the signal travels 300 m)!

Solution
- Use signals of 4 different satellites to determine 3D position
Sources of GNSS errors
Error Mitigation by Augmentation

Wide Area Augmentation System
- correction data
- Ground based Monitoring Network

Local Augmentation System
- correction data
- Monitor Station
- regional
- local
- DGPS station

Custom Texts:
- DGPS station
- Wide Area Augmentation System
- Local Augmentation System
- Ground based Monitoring Network
- correction data
- Monitor Station
- regional
- local
- DGPS station

Diagram Elements:
- Images of satellite and ground network
- Maps of global and regional coverage
- DGPS station setup

Textual Context:
In the context of intelligent transport systems, error mitigation by augmentation is a crucial aspect. This involves using additional systems to improve the accuracy of positioning data. The diagram illustrates two types of augmentation systems:

1. **Wide Area Augmentation System (WAAS):** Utilizes a global network of ground stations to broadcast correction data, which is received by satellite users to enhance the accuracy of their position. Examples include WAAS (Wide Area Augmentation System) and CONOR (CONtingent Orbit Determination Reference System).

2. **Local Augmentation System (LASS):** Provides more localized correction data, typically to a smaller area. This can be done through systems like RDS (Radio Data System) and ORF (Österreichischer Rundfunk), which transmit correction data to users in the vicinity.

These systems are designed to correct errors in satellite positioning data, thereby improving the reliability and precision of location services.
DGPS as RDS-ODA payload

- RTCM SC-104 DGPS protocol format is widely used by GPS manufacturers and are used as a guideline for DGPS via RDS
- The low data rates offered by RDS are suitable only for DGPS applications that are limited to ± 1..5 m accuracy
  - Confer, at e.g. 2.400 bps an accuracy of several centimeters would be possible
- RTCM format itself is unsuitable for RDS due to excessive bandwidth
  - Compression (and decompression at receiver) required
  - To achieve ± 5 m accuracy, 20-50 bps within RDS-ODA sufficient
  - (recall: one ODA group type A (e.g. 11A) can carry 37 payload bits)
- Example:
  - Type 1 RTCM message (most frequent one) is 500..700 bits long
  - Such message for 9 satellites (680 bits) is compressed to 9x37 = 333 bits as ODA payload, split and independent of other sats.
- No standardized mapping, split/reconstruct/mapping is proprietary!
Literature

Transport Protocol Experts Group (TPEG)
TPEG Overview

- Transport Protocol Experts Group (TPEG)
- Founded in 1998 by European Broadcasting Union (EBU)
- Standardized by CEN and ISO
- Broadcast transmission of language-independent multi-modal Traffic and Travel Information (TTI)
- TPEG Group and TMC Forum have merged to Traveller Information Services Association (TISA) in 2008
- Supported by mobile.info project led by BMW

<table>
<thead>
<tr>
<th>No. of layer</th>
<th>ISO/OSI ref model</th>
<th>TPEG protocol specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Application</td>
<td>TPEG</td>
</tr>
<tr>
<td>6</td>
<td>Presentation</td>
<td>Information encoding</td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
<td>Multiplexing</td>
</tr>
<tr>
<td>4</td>
<td>Transport</td>
<td>Encryption</td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
<td>Error detection/correction</td>
</tr>
<tr>
<td>2</td>
<td>Data Link</td>
<td>Arbitrary bearer</td>
</tr>
<tr>
<td>1</td>
<td>Physical</td>
<td></td>
</tr>
</tbody>
</table>
TPEG

Infrastructure

Information
Transmission

Vehicle

Manual Message
Generation

Information from
Databases

Automatic Message
Generation

Message Aggregation

Message Allocator

Route Guidance System

Route Calculation

Map Database

Message Presentation

mobile.info: TPEG Automotive

M. Röckl and T. Strang, 2009
# TPEG

## Drawbacks of RDS-TMC

<table>
<thead>
<tr>
<th>RDS-TMC</th>
<th>TPEG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited to a single bearer (RDS)</td>
<td>Bearer independent</td>
</tr>
<tr>
<td>Low data rate (~100 byte/s)</td>
<td>High data rates (depend on bearer)</td>
</tr>
<tr>
<td>Pre-defined event descriptions (max. $2^{11}$ types of events)</td>
<td>Extensible event types</td>
</tr>
<tr>
<td>Max. 300 messages at a time</td>
<td>Variable number of messages</td>
</tr>
<tr>
<td>Static location referencing according to pre-defined location table</td>
<td>Dynamic location referencing</td>
</tr>
<tr>
<td>No security mechanisms (e.g. message encryption, authentication)</td>
<td>Optional message encryption</td>
</tr>
<tr>
<td>No extensibility</td>
<td>Extensible (application plugins)</td>
</tr>
</tbody>
</table>

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**Application**

- Road Traffic Information
- Public Transport Information
- Weather Information

**Bearer**

- RDS
- GSM/UMTS
- DAB
- DMB
- Internet

**TPEG**
TPEG
Applications

- **RTM – Road Traffic Messages**
  - ACC
  - ACT
  - CON
  - DIV
  - FAC
  - HAZ
  - NFT
  - ORS
  - PER
  - PTI
  - SEC
  - VIS
  - WFA

- **PTI – Public Transport Information**
  - Timetable changes for busses, trains, ferries, planes, etc.

- **TEC – Traffic Event Compact**
  - Event-driven messages for road traffic information (e.g. congestion, roadworks, accidents)

- **PKI – Parking Information**
  - Static: Parking area information
  - Dynamic: Parking space availability

- … (more will be defined in the future)

M. Röckl and T. Strang, 2009
TPEG
Message format

Multiplexed data stream

Message Management Frame  Event Container (e.g. RTM)  Location Container

Message Management Frame  Event Container (e.g. PKI)  Location Container
TPEG
Message Management Container

- General specification of time (start & expiry times) and importance (severity) parameters
- Equal format for all application types

<table>
<thead>
<tr>
<th>MID</th>
<th>MGT</th>
<th>MET</th>
<th>VER</th>
<th>STA</th>
<th>STO</th>
<th>SEV</th>
<th>UNV</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message ID</td>
<td>Message Generation</td>
<td>Message Expiry Date and Time</td>
<td>Version Number</td>
<td>Start Date and Time</td>
<td>Stop Date and Time</td>
<td>Severity</td>
<td>Unverified Information</td>
<td>Cross Reference Information</td>
</tr>
</tbody>
</table>
TPEG Event Container

- Depending on the type of application (RTM, PKI, TEC,…) the event container can be based on different kinds of application data:
  - Individual transport: Accidents, congestion, road condition
  - Public transport: Availability, delay
  - Points-of-Interest: e.g. parking (occupancy, number of free parking lots)
- Events can be linked with cause-effect relation (accident causes congestion)
- Extendable (additional applications can be defined)
TPEG

TPEG Automotive Profile (TAP)

Profiles define fixed message types for specific application fields (e.g. automotive)

- **Traffic Event Compact (TEC):**
  - Event-driven messages for road traffic information (e.g. congestion, roadworks, accidents)
  - Similar to TMC

- **Local Hazard Warning (LHW):**
  - Dangerous situations (e.g. slippery road, obstacles, “ghost driver”)

- **Traffic Weather (WEA):**
  - Information about weather conditions

- **Traffic Flow and Prediction (TFP):**
  - Current and upcoming traffic states of the road network

- **Speed Info (SPI):**
  - E.g. temporal speed restrictions

- **Parking Info (PKI):**
  - Occupancy, number of free parking lots
TPEG Location Referencing

- **Definition:** Identification of parts of the road network and other geographic objects by specific codes

- **Pre-coded** (e.g. ALERT-C in TMC):
  - Locations are encoded using pre-defined location tables
  - E.g. Loc333-ext2-3km

- **On-The-Fly** (AGORA-C in TPEG):
  - Locations are encoded dynamically on demand (On-The-Fly)
  - Problem if map data for encoding and decoding of locations is different
  - Map acts a dynamic location table
  - Locations are encoded by a set of inter-linked coordinates (e.g. WGS-84) + mandatory and optional attributes
    - e.g. road section signature = \{functional road class, form-of-way, road descriptor, driving direction\}

Schneebauer, Wartenberg (2007): On-The-Fly Location Referencing

M. Röckl and T. Strang, 2009
TPEG
TMC/ALERT-C

- 2^{16} pre-defined hierarchical-ordered location codes for highway approaches, intersections, service stations, bridges and tunnels
- Distances between consecutive codes may be larger than 10 km → difficult to specify exact locations
- Location codes are linked to their predecessor and successor on the road network
- Linear locations are encoded by their start location and direction (e.g. \textit{Loc333, ext 2}) and the extent of locations till the stop location (e.g. 3km)
TPEG
AGORA-C

- Flexible, dynamic geo-referencing of traffic and safety-related information
- Standardized location description (i.e. set of reference points + meta information) on demand (on-the-fly) for the spatial footprint of a traffic message or safety alert
- Small size ("C" = compact) – less than 60 bytes
- 98% hit rate with 35 byte location codes is feasible
- Can be used as extension to ALERT-C when location code is not available
TPEG Location Container

- Different types:
  - ALERT-C: TMC location referencing
  - TPEG-Loc: Thin (w/o maps, only text) or thick (with maps) clients
  - AGORA-C: Only thick clients
  - VICS-Link: Japanese location referencing
  - Korean-Node-Link: Korean location referencing
Symmetric encryption (=shared keys) with cascading key hierarchy for:
- Individual devices: device key included in every device, en-/decryption of management data with service keys
- Services: en-/decryption of messages with temporary session keys (control word)
- Service data: en/decryption with control word, control word has to be changed frequently to prevent correlation attacks
TPEG Formats

- **TPEG Binary:**
  - Binary encoding
  - For transmission over *Digital Audio Broadcast (DAB)* or *Digital Multimedia Broadcast (DMB)*

- **tpegML:**
  - XML encoding
  - For transmission over the Internet or *Digital Video Broadcast (DVB)*
TPEG
tpegML

Source: http://www.bbc.co.uk/travelnews/tpeg/en/local/rtm/rtm_tpeg.xml

M. Röckl and T. Strang, 2009
There are roadworks (road signs work) on M5 Somerset southbound at J19, Portishead. The expected delay is 1 minute.

Source: http://www.bbc.co.uk/travelnews/tpeg/en/local/rtm/rtm_tpeg.xml
Recap: Wireless Interconnections
Networking types

Broadcast
+ Scalability
+ Range
– Delay
– Individuality

Cellular
– Scalability
– Range
+ Delay
+ Individuality

Ad-hoc
– Scalability
– Range
+ Delay
+ Individuality

Relevance

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Wireless Interconnections
Cellular

Why cellular?
- Medium range: up to tens of kilometers to next base station
- High penetration & coverage
- Average scalability: usable with millions of receivers

Cellular is superior to other technologies to distribute information that
- is relevant for specific users (point to point),
- comprises medium amount of data

Disadvantages of cellular:
- Expensive for end-user, particular if roaming
- SIM-card management is not negligible
- Requires addressing and link setup
Example for use of Cellular:
Why time matters - Golden Hour principle

Dr. M. Cara, 1981
eCall Information Flow

MSD: Minimum set of data
FSD: Full set of data
PSAP: Public Safety Answering Point
eCall Requirements for Cellular (GSM)

- Transmission of vehicle MSD (140 bytes) *simultaneously* with voice call
- Transmission of MSD must be *fast* (*< 4 sec*) and *reliable* (*acknowledged*)
- Capability of MSD transmission when *roaming abroad* (*using free 112 call*)
- *No modifications to existing cellular networks should be necessary*
- Robust and Reliable communication system with high degree of availability, bidirectional point-to-point
  - SMS
    - *SMS transmission may be delayed and not prioritized*
    - *But preferred by some institutions, such as Steiger-Stiftung*
  - Out-of-bands modems
    - *Data channels may not be available everywhere, usually not prioritized*
  - In-band modems
    - *Endorsed by 3GPP in the meantime*
eCall in-band modem with cellular architecture

- PSAP operator initiates MSD transmission
  - (MSD could also be transmitted automatically)
- Voice path is muted until MSD is correctly received
Traditional timeline (phone call only, without MSD)

- Accident occurrence time before detection and reporting. Range: Days – hours – minutes
- Set up call, 5 secs
- Transmission time 4 secs.
- Arriving at PSAP Answering 5 – 10 secs Average = 7 secs.
- Evaluation and forwarding to 2nd stage PSAPs/ control room. 10 -90 secs
- 2nd stage PSAP/ control room answer 90% of incoming calls within 10 secs
- Dispatch time. 60 – 90 secs
- Arriving at the scene 6 – 15 minutes, 1st assessment
- Control room answer 90% of incoming calls within 10 secs
- Dispatch time. 60 – 90 secs
- Arriving at the scene 6 – 15 minutes, 1st assessment
- 2nd dispatching after assessment, Time starts counting again.

[Source: PSAP Expert meeting on eCall, 2006]
Lecture
Intelligent Transport Systems
Prof. Dr. Thomas Strang, SS 2010

MSD time potential

[Source: PSAP Expert meeting on eCall, 2006]
Location accuracy required for eCall

- 50 – 100 m considered sufficient by the eCall expert group
- For the sake of swift implementation.
- Natural migration to better accuracy expected.
- PSAPs will monitor that and modify their requirements when technical feasible, also considering cost – benefit aspects.
- Expectation when combined Galileo – GPS is available:
  - More robust.
  - More accurate
  - Also in problem areas
Why aiming for best accuracy?

- Accurate route guidance and pre-empting the route to the incident via the fastest possible route; the Golden Hour principle counts here!
- Distinguish exactly the lane where the incident occurred, to be connected to traffic control systems in the future.
- At a ditch or a canal, 1 meter will give the proper distinction on what side of the ditch or canal the incident occurred, next bridge may be 10 km away!
- Canyons and gorges in mountainous likewise.
- A car can simply vanish into the shrub, a few years ago there was an example on London’s M25 orbital ring road. A car was detected only after 5 weeks!
- A car can get submersed without leaving a trace; the water plants floating on the surface can render a car totally invisible from the shore.
- Last known position as accurate as possible to define search area.
Integrated Communication System

Only PSAP operator can terminate the eCall.
- To reassure people.
- To try to keep them conscious.
- To operate longer term activities (pursuits).

Vehicle-integrated communication system.
- Car should talk to the PSAP operator, not GSM mobile.
  - Mobile device could easily get lost in case of a crash.
  - Person can be trapped, not able to reach the mobile if it is lost from its bracket.
- Solid mike & speaker

Ensure that both 112 Voice and MSD reach the same PSAP operator
Minimum Set of Data, PSAP perspective

- PSAPs/emergency services need additional data to assess seriousness and parallel dispatching
  - Timestamp
  - Location including direction of travel
  - Vehicle identification
  - Service provider identifier
  - eCall qualifier

- PSAPs require the MSD
  - As defined in GST Rescue.
  - Being standardised by ISO/CEN

- PSAPs agreed to consolidate but express the need for further development as technology improves over time.
Performance criteria, PSAP perspective

- Map accuracy
  - 15 meters – measured against WGS84
  - Road geometry – lowest local level
  - Road naming – Each road must have a name

- Operational procedures
  - Answering incoming emergency calls
  - Evaluation of incoming calls
  - Forwarding to 2nd stage PSAP or emergency control room
  - Answering of incoming emergency calls from the 112 centre by the 2nd stage PSAP or emergency control room
  - Dispatching of emergency unit
  - Time to arrive on the location of the emergency

- Timing
  - <10 Sec. For voice response
  - <10 Sec. For receiving the MSD and visualising the location
ADAC eCall Field Study in 2007

- March-Mai 2007, Germany/Austria/Italy
- Proof of concept, in particular for cross-country aspects
- Using in-band GSM modems to transmit MSD to national call center (ÖAMTC-Wien, ADAC-Halle and ACI-Milano)
- Test calls at about 450 locations in 3 countries
- Out of 834 calls, 773 successful (93%)

[Source: ADAC]
ADAC eCall Field Study in 2007 (cont’d)

- 94% of the eCalls reached the call centers within 35 seconds, which is significantly better than early requirements\(^1\) (85%)

\[^1\] requirements more stringent in the meantime

[Source: ADAC]