Name of the project (also for public affairs)

RUBIN = Realisation of an automated metro in Nuremberg

See also www.rubin-nuernberg.de
Horse Powered
Steam Powered
Electricity Powered
Metro System
Main Data

Number of Passengers

- Metro 60%
- Tram 12%
- Bus 28%

Total: 168 Million Passengers / Year

Data 2001

Line Length

- Metro 4.4%
- Tram 6.1%
- Bus 89.5%

Total: 689 km Line Length
• 32 km network
• 40 stations
• 81 two-car units
• 200 s service intervals
• 300 000 passengers daily
Metro Network: Phase 1, Unattended Train Operation U3

Opening  Begin 2008
14 Vehicles

Optimal Preconditions for UTO in Nuremberg

- Extension of metro network (U3)
- Demand for new vehicles
- Replacement of older rolling stock
- Branching problem of Lines U2/U3
Metro Network: Phase 2, Unattended Train Operation U2/U3

Changeover End of 2008

16 Vehicles
100 s service intervals
• 40 km of tracks
• 50 stations
• 97 two-car units
• 100 s service intervals
• 350,000 passengers daily
• Lines U2 and U3 completely underground
Feasibility Study

Work Package Part 1

Operations Concept
- Operation of Existing Metro
  - Disturbances
  - Automatic Operation
  - Personnel Concept

UTO Concept
- Basic Concept
- Basic Functions
- Passenger Platform Safety

Changeover Strategy
- Operational Point of View
- Technical Point of View
- Economic Analysis
## Work Package Part 2

<table>
<thead>
<tr>
<th>Safety of Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Acceptance Study</td>
</tr>
<tr>
<td>Emergency and Rescue Procedures</td>
</tr>
<tr>
<td>Safety and Availability</td>
</tr>
</tbody>
</table>
1. UTO in Nuremberg is **economic** and **useful**

   A calculation of economic efficiency has been done based on budget prices of rail industry

2. Technical **feasibility** is **possible**

   Planed system is capable to get authority approvals and is conform with German and European laws, standards and regulations (BOStrab, RIFoF, VDV 399 and CENELEC standards)

3. UTO in Nuremberg ensures **future-oriented way of operation**
Change Strategy: Advantages of UTO

- Less personnel (95)
- Service crew for passengers instead of drivers
- Reliability
- Greater safety for passengers
- Short service intervals = less waiting time for the passengers
- Flexible train service for peak hours
- Fewer vehicles = lower investment (-38Mio €)
- Energy savings
- Attractive service => more passengers

Higher performance
Less expenditure
Overall Costs 612 Mio. Euro

- **Construction Line U3** (360 Mio. Euro)
  Contains everything, which would also be necessary for a conventional metro (Tunnel, power supply, tracks, third rail, ...)

- **UTO** (112 Mio. Euro)

- **Vehicles** (140 Mio. Euro)
  37 two-car-trains
Total Costs UTO - System

$\sum = 112$ Mio. Euro
Construction Changes Line 2

- Space was needed for additional wayside computers
- Doors at the end of the platform are to be installed

1,4 Mio. Euro
Interlocking Line U3

- Maintenance vehicles have no ATC equipment
- Fall back level in case of ATC disturbance
ATC System (Wayside & Onboard)

- Costs split as follows:
  - Test track at depot: 5.3 Mio. Euro
  - Line U3 (8.6 km): 14.2 Mio. Euro
  - Onboard (37 vehicles): 10.0 Mio. Euro
- Technology: Transmission via track conductor loop
CCTV (Wayside & Onboard)

3,9 Mio. Euro

• Costs split as follows:
  - Wayside: 2,6 Mio. Euro
  - Onboard: 1,3 Mio. Euro

• Wireless LAN for video transmission vehicle -> wayside

• The vehicle transmits important data via wireless LAN to the workshop and maintenance personnel can get data on demand respectively
Guideway Intrusion Detection System

- Platform length 90 m
- 0.33 Mio. Euro per station

8.9 Mio. Euro
Operations Control Centre

25.6 Mio. Euro
Project Management & Reorganisation of Operation

- Planning
- New operational procedures
- Training staff
- Testing
- ...
Customer and System Service - A new job profile

- communication skills
- wide knowledge of the public transport system
- an assured bearing
- a positive corporate attitude
- courtesy and good etiquette
- trained in de-escalation skills
- simple maintenance skills
Economic Advantages (compared to conventional operation)

• 95 less personnel

• Less energy needed
  Energy optimised speed profile
  Synchronisation of accelerating and decelerating vehicles

• Fewer vehicles needed
  38 Mio. Euro less investment
AGT Add-on

OC trivial

ATC

Interlocking

Track conductor loop

Passenger Platform Safety System

ZZA = Track Display
ELA = Loudspeaker

Notruf

Notfall

Bahnsteigtelefon
Diagnosis system for vehicles in depot

- Connection via wireless-LAN
  - Vehicle <-> wayside
- Connection via digital radio
  - Vehicle <-> wayside

Video data

Radio connection to emergency call desk

Diagnosis data

- Operations control center
- Interlocking system
- ATC system
  - ATC wayside computer (ATC-WSC)
  - ATC back channel computer (ATC-BCC)
  - Track conductor loops (LL)
- Platform safety system
  - Platform track monitoring (PSM)
  - Platform track observation (PBO)
  - Trespasser monitoring (TDM)
  - Long coupling area monitoring (LCAM)
  - Platform end doors (ADK)
  - Emergency stop switch (ESS)
  - Platform safety controller (CPC)

passenger information
- Passenger information displays (ZZA)
- Platform head- and inf boxes

interlocking system
- Relay interlocking system (RSTW)
- Electronic interlocking system (ESTW)
- Signaling system

ATC system
- ATC wayside computer (ATC-WSC)
- ATC back channel computer (ATC-BCC)
- Track conductor loops (LL)

platform safety system
- Platform track monitoring (PSM)
- Platform track observation (PBO)
- Trespasser monitoring (TDM)
- Long coupling area monitoring (LCAM)
- Platform end doors (ADK)
- Emergency stop switch (ESS)
- Platform safety controller (CPC)
**Data wayside -> vehicle:**
- clear of way
- speed limits
- stopping points
- temp. speed restrictions
- schedule data

**Data vehicle -> wayside:**
- vehicle position
- diagnosis data

---

ATC Data Communication diagram:

- ATC wayside computer
- ATC back channel computer
- Relay interlocking system
- Loop connection
- Passenger platform safety system
- Track conductor loop

- 36 kHz 1200 Bit/s
- 56 kHz 1200 Bit/s

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ATC Data Communication
ATC System
Passenger Platform Safety

Open systems

Closed systems

PARIS
LILLE
LONDON
COPENHAGEN
LYON
VANCOUVER
COPENHAGEN
Platform Screen Doors vs. Passenger Platform Safety System

Advantages Platform Doors:
- Air Conditioned Stations possible
- Less Waste in Platform Track Area
- Apparent Safety / Acceptance
- Create Fire Zones (Platform / Tunnel)
- No Suicide possible

Advantages PPSS:
- Less Stopping Accuracy needed
- Mixed Operation possible
- Less Investment
- Less Maintenance
- Independent of curved Platforms
Passenger Platform Safety System

- Intrusion Detection
- Analysis of Disturbances and Recognition of Danger Situations
- Intrusion Detection
- Detection of Objects within Track Area by Means of a Radar System
Passenger Platform Safety System

- 24 GHz
- Diameter Test Object: 30 cm
- Weight Test Object: 10 kg
- Distance of Rays: 15 cm
Passenger Platform Safety System
Workplace OCC

- Dispatch/schedule system
- Controlling and monitoring
- Signalling and ATC
- Controlling and monitoring vehicles
- Platform track observation by video
- Vehicle observation by video
- Reporting
- Radio
CCTV inside the train

Surveillance of the cabin
- in conditions of danger
- Subjective security
- Prevention of vandalism

Transmision from cabin to OCC
per WLAN im 2,4 GHz-ISM-Band
- acc. IEEE-Standard 802.11b / DSSS
- transmission power < 0,1 W
- encrypted transmission
  transmission: WPA / program: propr.
- 4 cameras parallel (U2/U3) - also from 2
  different trains
- until 24 fps from the same train
CCTV inside the train
CCTV inside the train
New Vehicle Features

- Sensitive Door Rubber Lip
- Door Emergency Locking
- Door Closing Signal
- Video Surveillance
- Auxiliary Driving Panel
- Emergency Call
- Fire Detectors
- Diagnosis
- Coupling
- RAMS
- ATC
- Folding Ramp
- Short-Circuit Third Rail
- Obstacle Detector
- Derailment Detectors

Equipment for conventional operation
Equipment for automated operation
What kind of expectations do you have in a future metro?

- 31% Low Prices
- 16% More Service Staff
- 18% Better Connections To Bus And Rail
- 15% Less Waiting Time
- 9% Use Of Modern Technology
- 6% Arrival On Time
- 5% Other

Results of Passenger Opinion Poll
Concerns regarding a driverless metro system

- No concerns: 29%
- Worried about proper function of technique: 26%
- No contact person: 18%
- Impersonal: 10%
- Afraid of crime: 7%
- Increases unemployment rate: 1%
- General concerns: 9%
Automation of Metros Requires:

1. Clear benefit for the passengers
2. Profound feasibility study
3. Courage of politicians
4. Esprit de corps / common spirit
5. Constructive decision makers
6. Powers of persuasion
7. Optimal launching conditions
8. As few as possible interfaces for the operator
9. Comprehensive staff and training concept
10. Strategic communication concept
Automatic Metro Train DT3
Auxiliary Driving Panel DT3
Thank you very much for your attention
Financing of 612 Mio. Euro

- **Line U3 360 Mio. Euro**
  - Investment by the city of Nuremberg according to federal and Bavarian law
  - 85% funded

- **UTO 112 Mio. Euro**
  - Investment by the city of Nuremberg according to federal and Bavarian law
  - 87.5% funded

- **Vehicles 140 Mio. Euro**
  - Investment by VAG Nürnberg for vehicles according to federal law
  - 50% funded
Project **RUBIN** - Kurt Graf, VAG Nuremberg

**Our way in Nuremberg** from a feasibility study to the final realisation

Existing **preconditions** in metro network and rolling stock

Results of the **feasibility study**

Overall **Costs** – **Add-on** for unattended train operation UTO

UTO-System - **Technical equipment** wayside and onboard

**Operation control centre**

**Passenger platform safety**

**Experience** in launching the system