

WMATA's 7000-series Rapid Transit Car – WMATA's Leap Forward in Technology

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Today's Discussion

- Setting the Stage
- Proactive Design Development
- Improved Crash Energy Management (CEM)
- Upgraded Networks and Communications
- Where we stand



Current Fleet

- Over 1000 total cars in six fleets
- WMATA terminology
 - First car order: 1000-series – “1K”
 - Sixth car order: 6000-series – “6K”
 - Seventh car order: 7000-series – “7K”
- “1K” through “6K”
 - Fully interoperable
 - Built to same technological template
 - Emphasis on technical commonality



The Implications of Interoperability

- Flexibility in operations
- Relies on technical commonality and compatibility
- Based on fundamentals of mid-1970's era technical solutions
- Incremental technical improvements over time
- Preserve backwards compatibility at the expense of further innovation



7K Car is the Turning Point

- Technology has changed dramatically since “1K”
- Advanced, service-proven technologies readily available
- Interoperability - an impediment to incorporating these new technologies
- Decision - “7K” to adopt new technologies, drop full interoperability



The Pressing Need for 7K

- Current Order: 528 cars
- Additional Options: Up to 220 cars
- Current Order provides:
 - Capacity for Dulles Airport Extension
 - Retirement of 1000-series fleet
- Options would allow:
 - Expansion of standard train to eight cars
 - Permit retirement of additional older cars



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Partnering Charter

- Re-thinking of traditional design relationships
- Define a new pattern for communicating



Charter: We – WMATA, Kawasaki and the suppliers – commit to a world-class railcar for the Nation's capital. As partners we pledge ourselves to open, honest communications to build trust. As a single team we will strive to design and build the perfect car.

Car Mockup

- **Original Plan:** Individual , non-functional, mock-ups of interior, cab, underfloor, etc.
- **Partnering solution:** Consolidate into a single “hard” mock-up of an entire car
- **Result:** Stainless steel carshell using actual products and materials as much as possible
- **Ongoing:** Hard mock-up kept up-to-date as items evolved to Final Design



Exterior of Hard Mock-up

Full Car Mock-up Results

- 3-D proving ground
- Check physical interfaces
- See car appearance
- Conduct internal engineering tests
- Early ID of problems; tool for their resolution
- Improve production learning curve
- Presentation to news media and public

Hard mock-up allowed Kawasaki and WMATA to produce a better car quicker



Design Verification Reviews (DVR)

- Production / testing of functional individual products at Preliminary Design stage
 - Performance
 - Maintainability
 - Manufacturability
- DVR of Hard mock-up too
- Results used to
 - Improve designs
 - Streamline manufacturing
 - Before Final Design Review



Interior of Hard Mock-up

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Crash Energy Management Requirements

- 5 mph collision:
 - Damage limited to replaceable sacrificial elements in coupler and anti-climber
- 20 mph collision:
 - Damage limited to carbody crush zones
 - Control propensity to override and telescope
 - Limit passenger accelerations



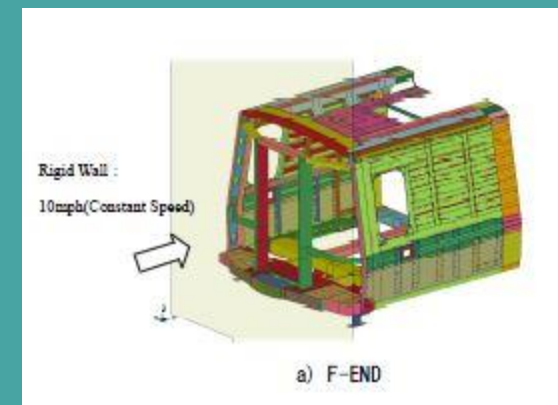
Working with CEM Models

- Define loads
 - Service and emergency loads
 - Static and fatigue loads
- Sophisticated Analysis models / methods
- Static load testing to fine-tune models
- Consider practical limits to validation



Analyzing CEM Results

- Plan: Two-stage crush zone:
 1. Replaceable absorption elements in anti-climber
 2. Non-replaceable main absorption elements between anti-climber and carbody bolster
- Problem:
 - 40% of energy was absorbed elements not included in CEM design.
 - How to verify model?
- Response: Conduct dynamic crash test



Crush Zone FE Model

Test the Model

- Caution: Only one test specimen
- Result: Performance agreed with analytical results with acceptable accuracy
- Conclusion: There is no substitute for appropriate testing to verify model accuracy and structural response



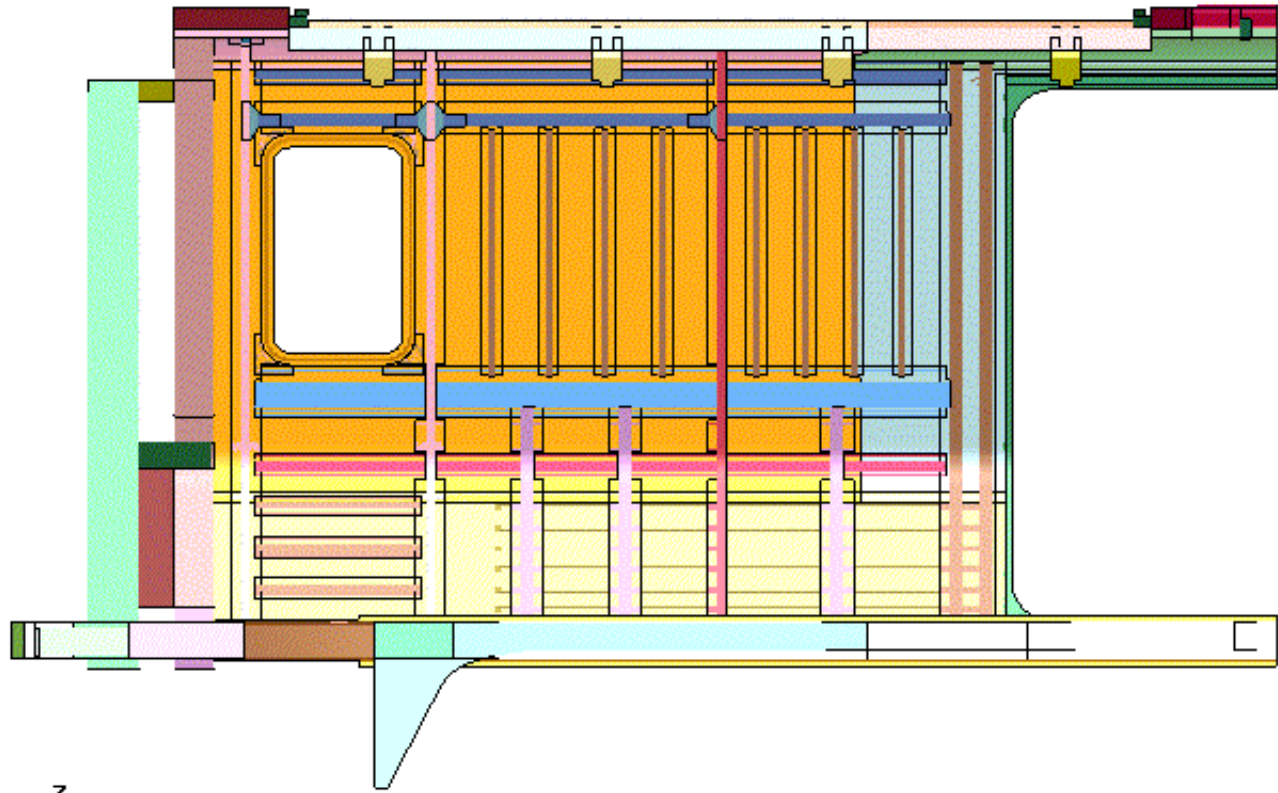
Dynamic Crash Test Articlee



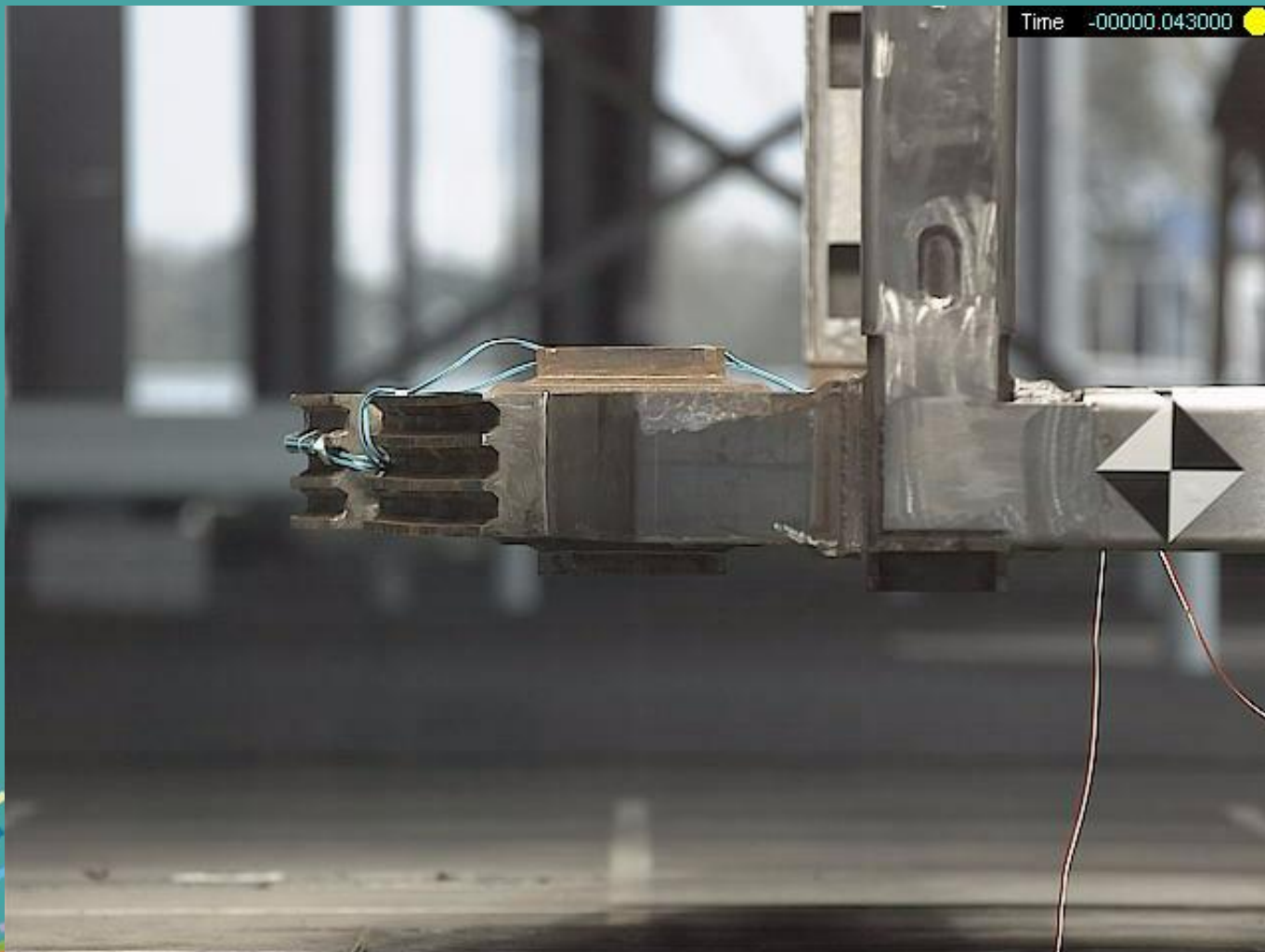
Dynamic Crash Test Article, Post- Test

Crush Analysis

Time = 0



Dynamic Test – Side View



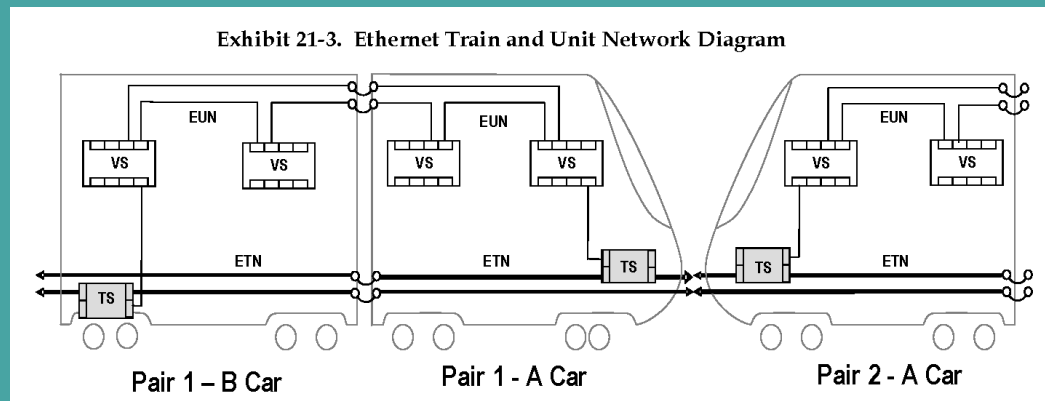
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Network Architecture

- Network functionality includes:
 - Train control,
 - Digital audio,
 - Video surveillance, and
 - Diagnostics
- IEEE Std 1473™ network compliance
 - TCN for control – Ethernet for data



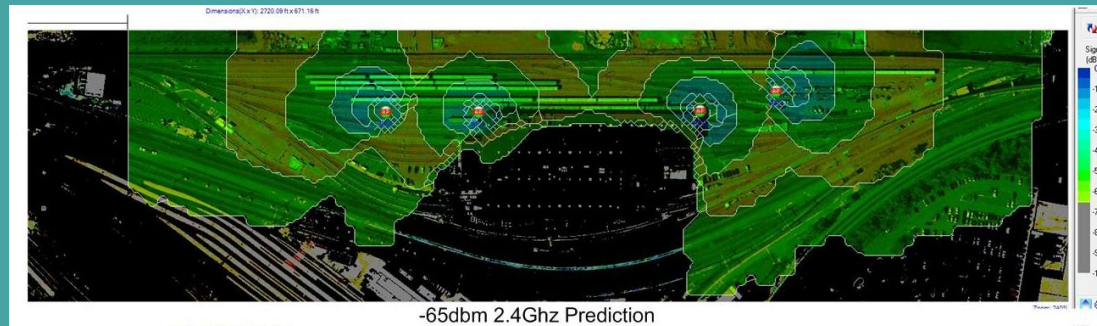
Select Network Features

- Universal Service Port
 - Communicate with all vehicle systems across an entire train
 - Full PTU functionality - remotely
- Interface documentation
 - Not just for this project
 - Preparatory to next fleet procurement



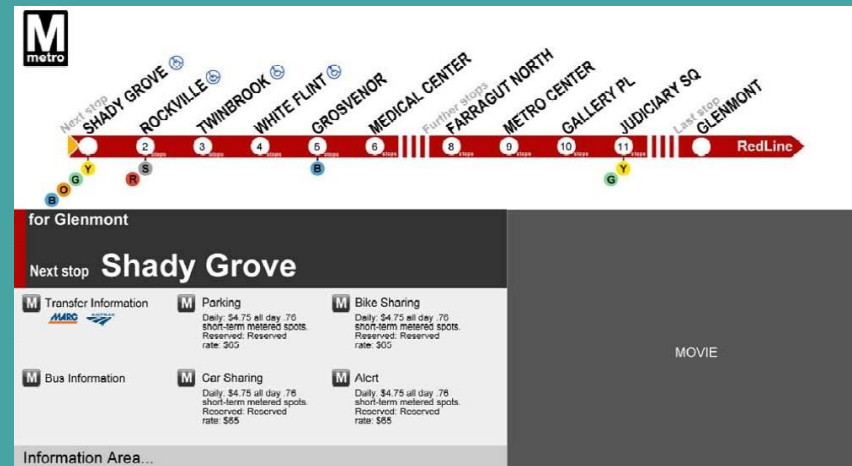
Train-to-Wayside WiFi Communication

- Link between cars and nine WMATA yards
 - Eventually stations too
- Uploads of announcements and videos
 - Including triggers by station stops
- Downloads of diagnostic and video data
 - Web access to server-based data storage
- Integrated WiFi solution
 - Not exclusive to one system or car type



Door Pocket Display

- Video screen; very flexible re: content
- Consolidated display of passenger information
- Line map/train destination
- Which side doors will open at next stop
- Next station data (connecting services, parking, etc.)
- Information scroll bar
- Movie display (public service and commercial messages)



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Where We Stand

- Prototype cars are in test in Japan
- Pilot cars are in manufacture in Nebraska
- Pilot delivery to WMATA this year

All elements are coming together for the
7000-series car
WMATA's Leap Forward in Technology



Questions?



7000-Series Car Front End