Digital Train Comm. Network

A study for development of low cost alternative

Presentation Overview

- The need

- Standards

- Requirements

- Network technology selection

- Proposed network architecture

- Road Map for Development

- Cost of Deployment

- Questions?

The Need

- **UIC CODE 660**: *Technical Compatibility of high speed trains*
  - Max. Axle Loads
  - Min. acceleration values
  - Safety requirements
    - Bogie Stability
    - Bearing Monitoring
    - Alarms
    - Brake application
    - Speed control

Photo: Source Wikipedia

- Siemens Velaro
  - DB ICE (Germany)
  - RENFE (Spain)
  - CRH (China)
  - RZD (Russia)
  - Eurostar
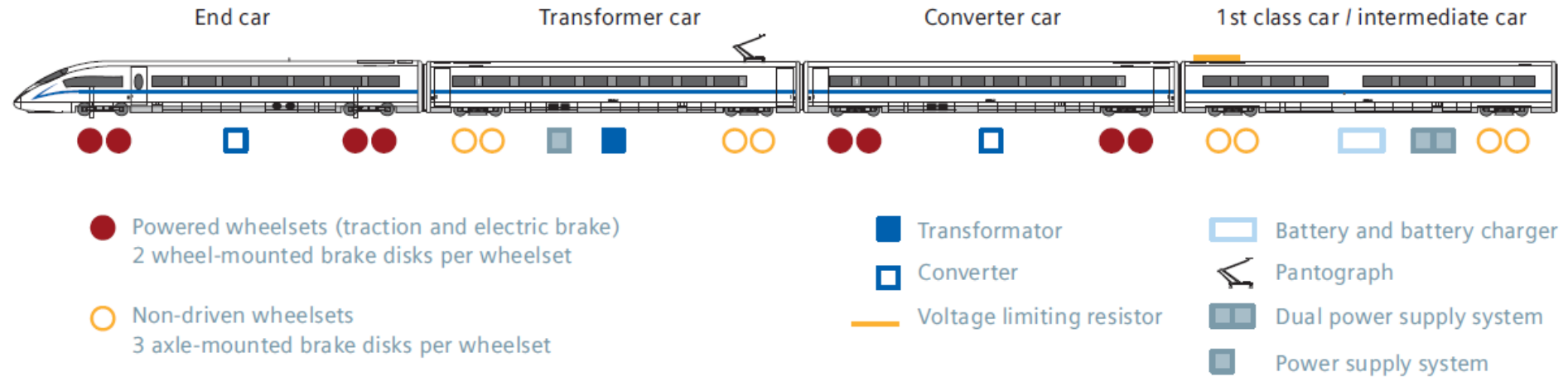 - TCDD (Turkey)

The Need

Figure : Source Siemens Velaro Datasheet

- Distribution of equipment over train set
- Requires mission critical control communications
- Dedicated analog wiring is not a solution
  - Complexity & Cost
  - Maintainability & Reliability
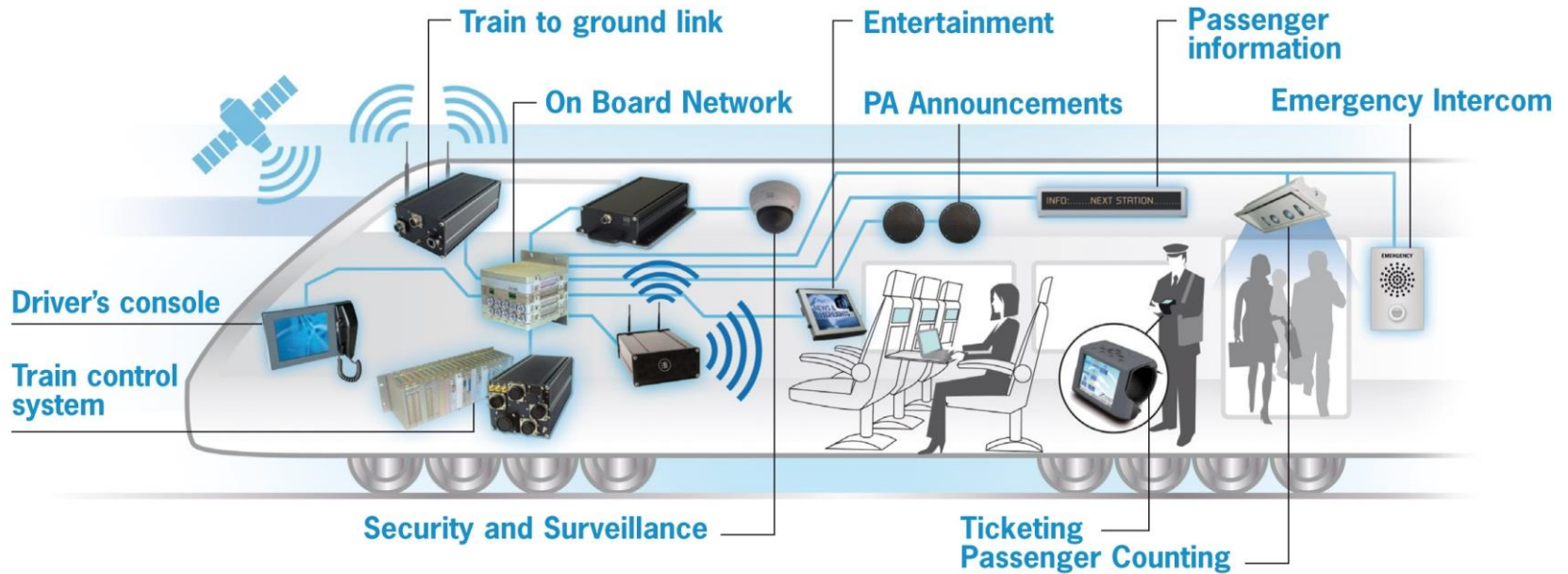
The Need: Wiring Complexity & Cost

- Powered Bogie Monitoring
  - 17 sensors
  - 2 buses
    - Power
    - Comm.
- In analog form
  - 17 cables from each bogie!
  - A Rat's nest!

Figure: Source SKF Product Datasheet
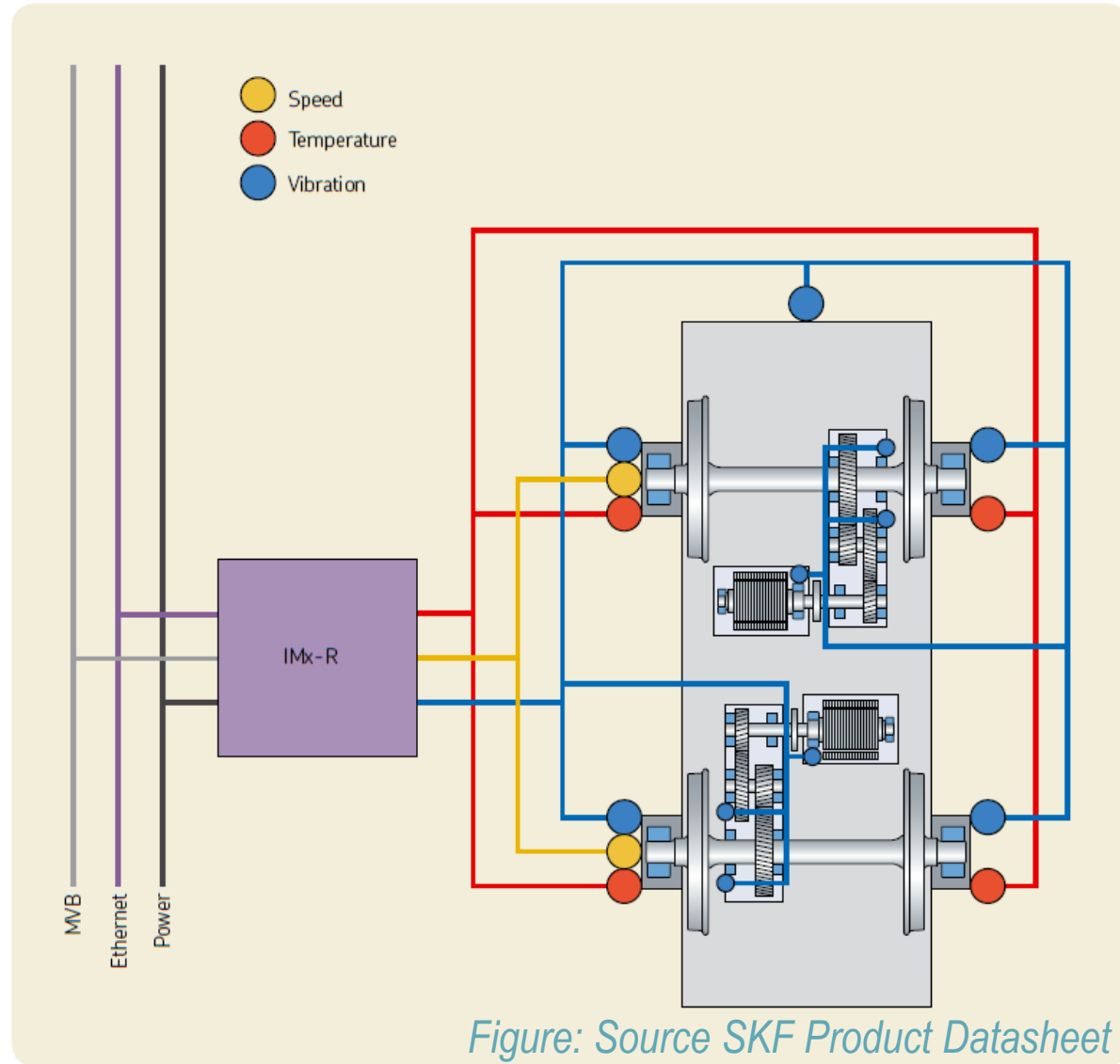
The Need

- Requirement of a communication network

  - High availability

  - Deterministic

  - Fault tolerant

  - Standard

  - Interoperable

The Need

- Network Infrastructure for TCMS

Survey: Technology / Standards

- UIC
  - IEC 61375
    - MVB / WTB (2007)
    - CCN / ETB (2012)
  - UIC 556
- AAR
  - S-590
  - S-9356
  - M-9155

- Proprietary implementation
  - Ethernet only
  - CAN / CAN Powerline
  - Lonworks

- Problem with standards is implementation is not standardized

- Cost and suitability?

- *Which one ? Or a New One*

Identified Requirements

- Application Requirements
  - Control Communications
    - Intra-vehicle
    - Inter-vehicle
    - External to the train (train to ground & train to train)
  - Passenger Infotainment
    - Displays and announcement
    - Media Streaming
   - Internet Access
  - Surveillance Systems

Network Technology: Selection

- Initially planned only on Ethernet
- CON'S
  - Lack of determinism
  - Heavy computing resource requirement
  - Low data efficiency for low volume data transfer
- Consensus for 2-tier approach
  - Between controllers on a vehicle
  - Between vehicles of a train
  - Train to ground to be handled by gateways
   - Outside the scope of this project

Technology Selection: Criteria

Criteria Category	Sub-Criteria	Capability / Requirement	
		Low (1)	High (10)
Nature of Data	Volume	Low	High
	Speed	Low	High
	Latency	High	Low
	Determinism	Low	High
	Security	Poor	Reliable
	Error Tolerance	Poor	Reliable
Complexity of implementation	On-board resources	Heavy	Light
	Supporting ecosystem	Limited	Vast
Physical characteristics	Distance	Short	Long
	Noise immunity	Poor	Good
Features at lower layers	Plug & Play	Poor	Rich
	Fault recovery	Poor	Rich
Equipment Cost	Cost	High	Low

Technology Selection: Criteria for VB
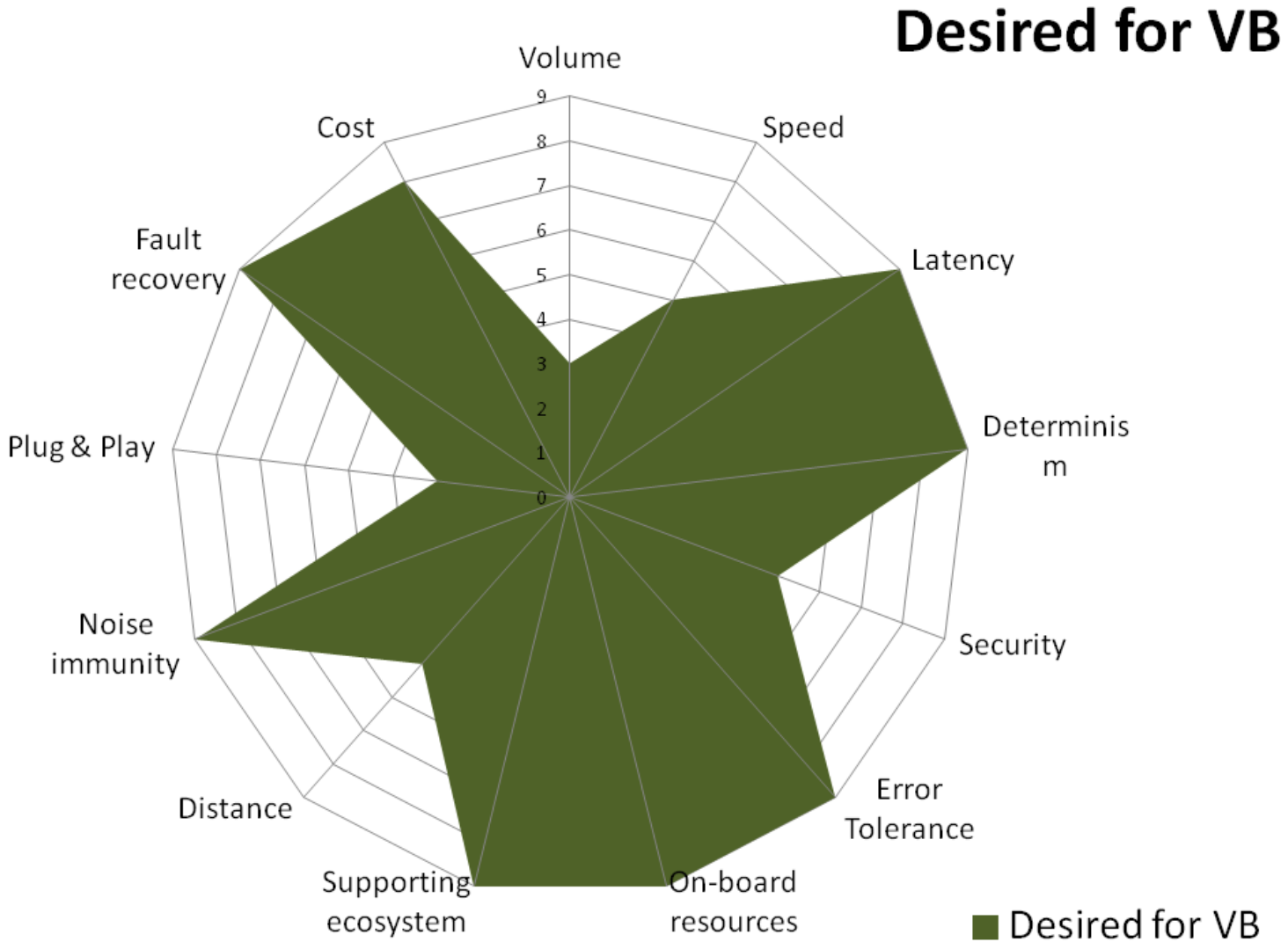
Desired for VB

Technology Selection: Criteria for VB

CAN as VB
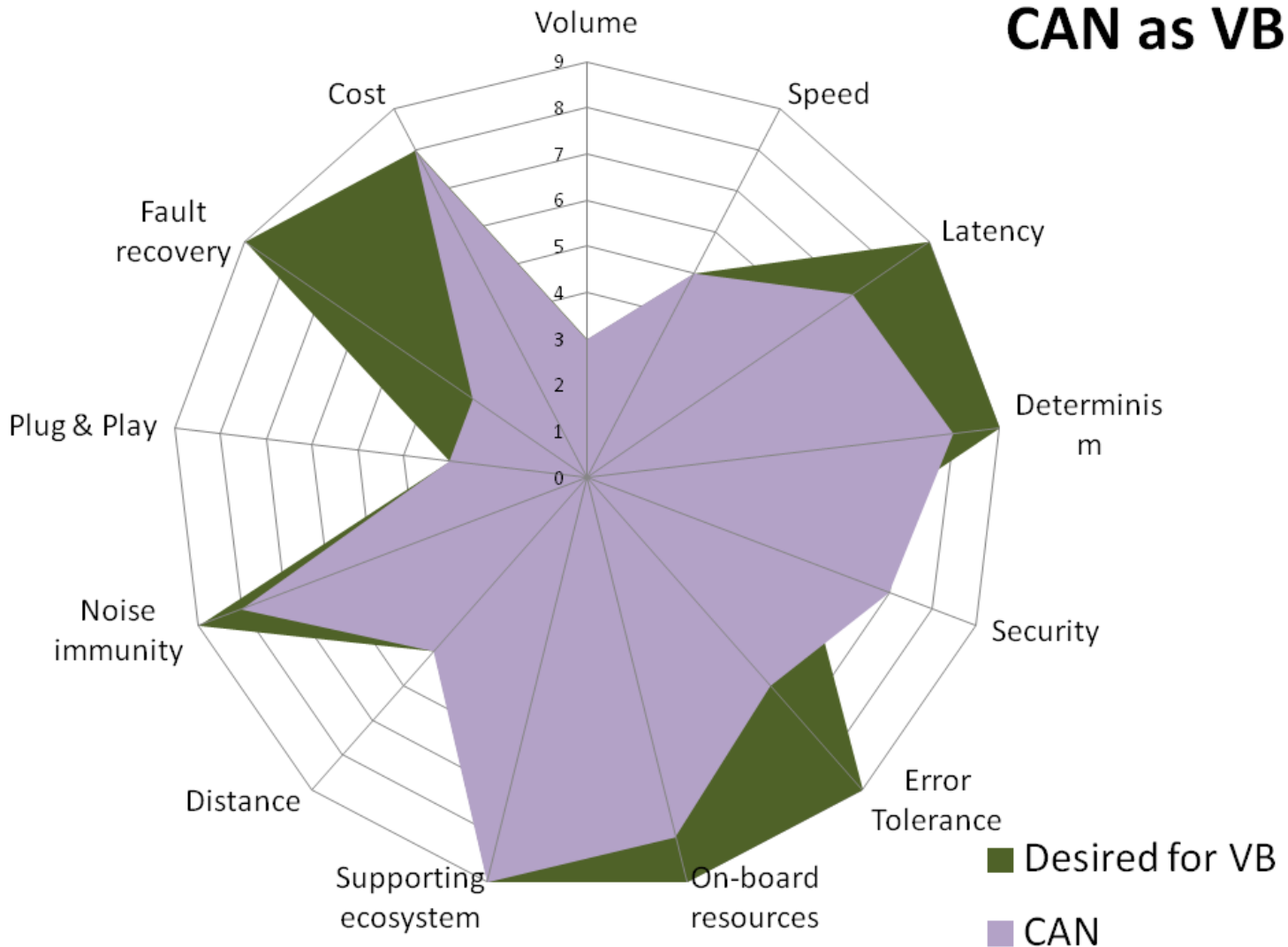
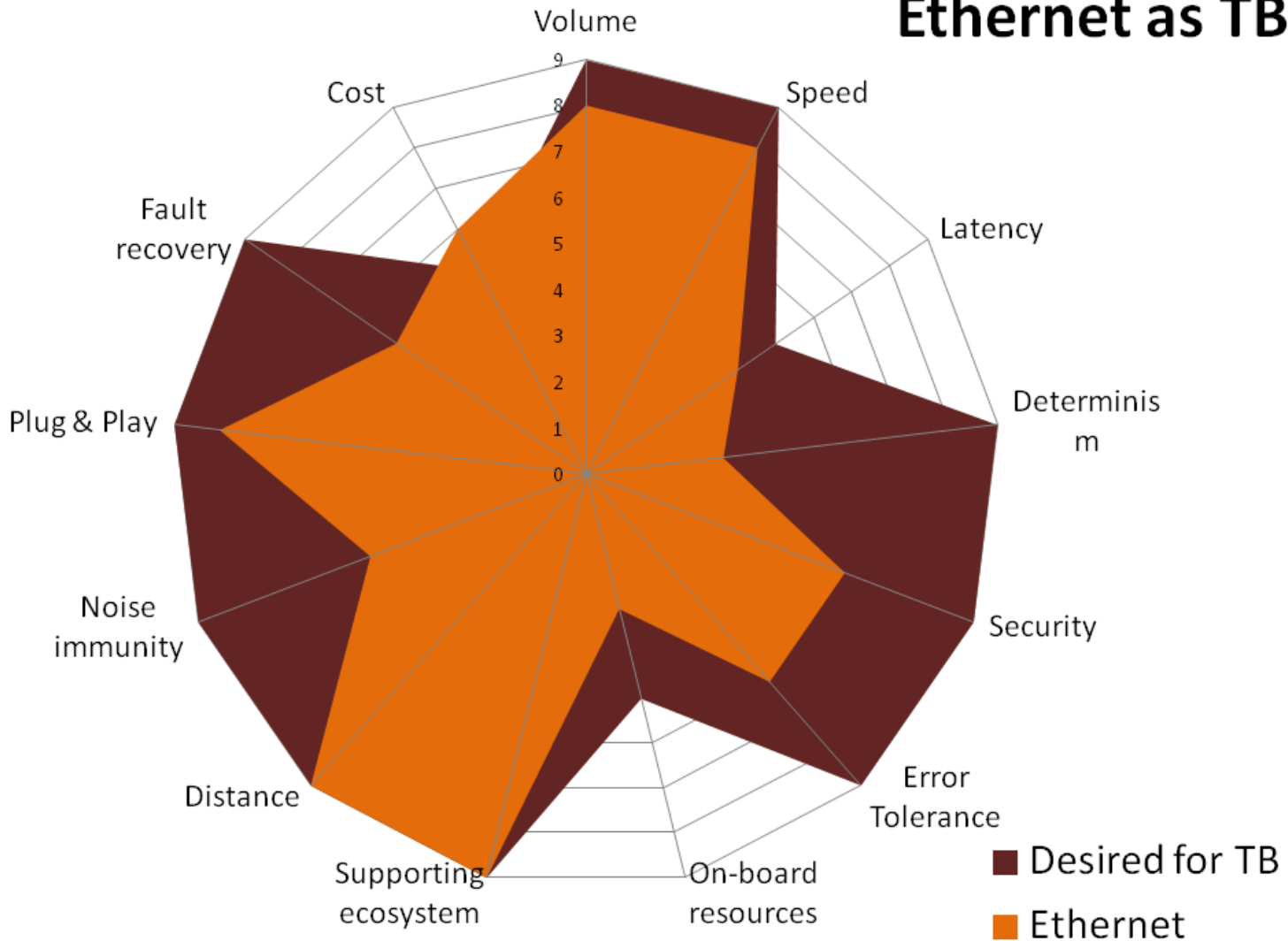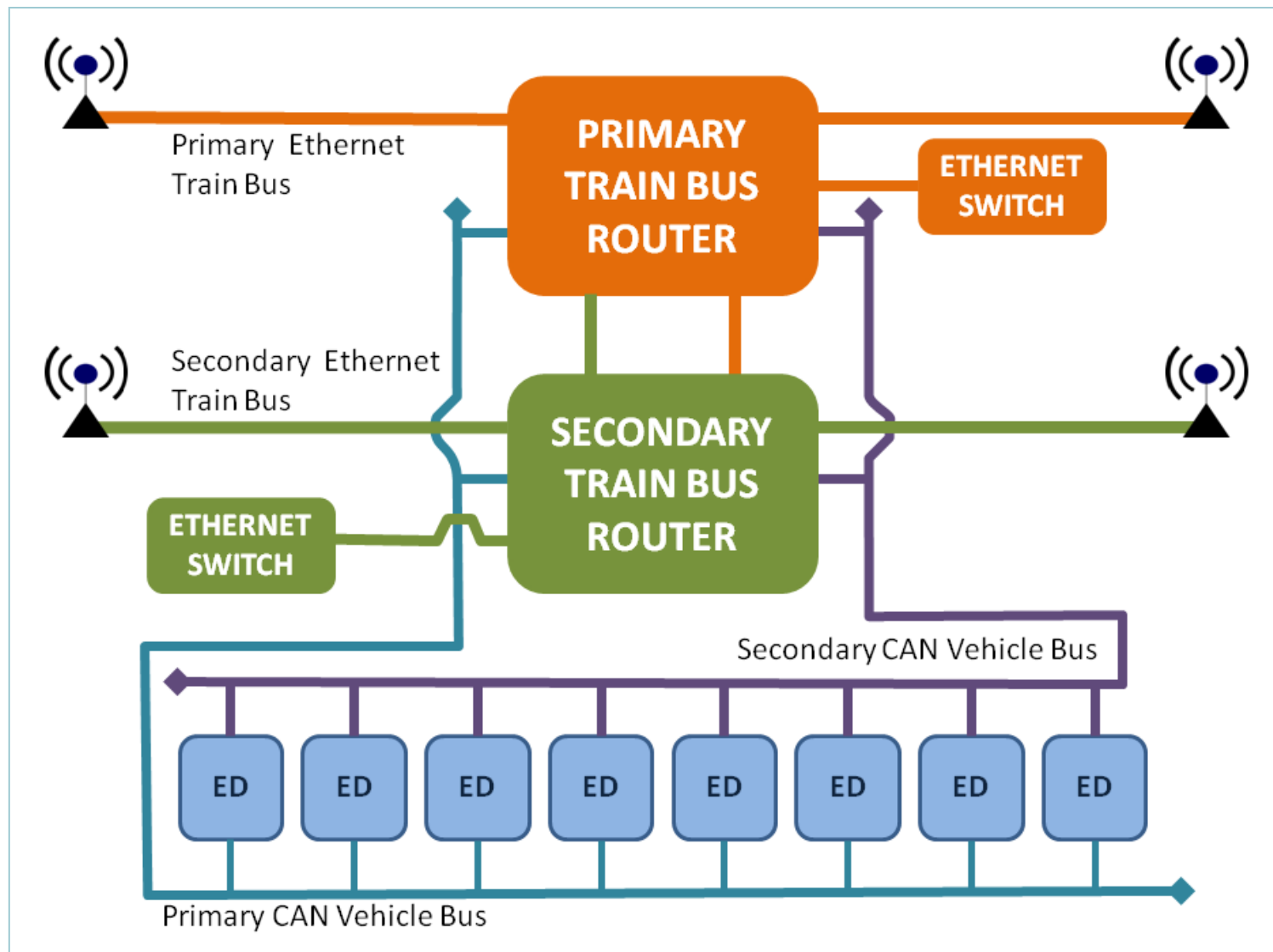Desired for VB
CAN

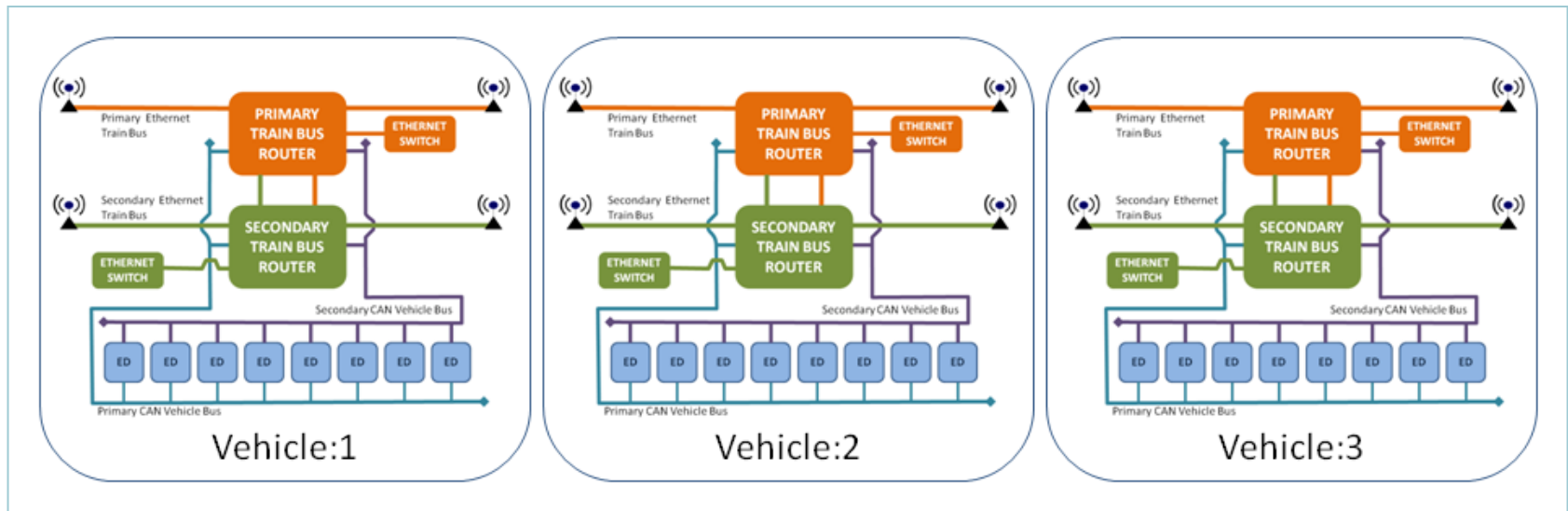Desired for TB
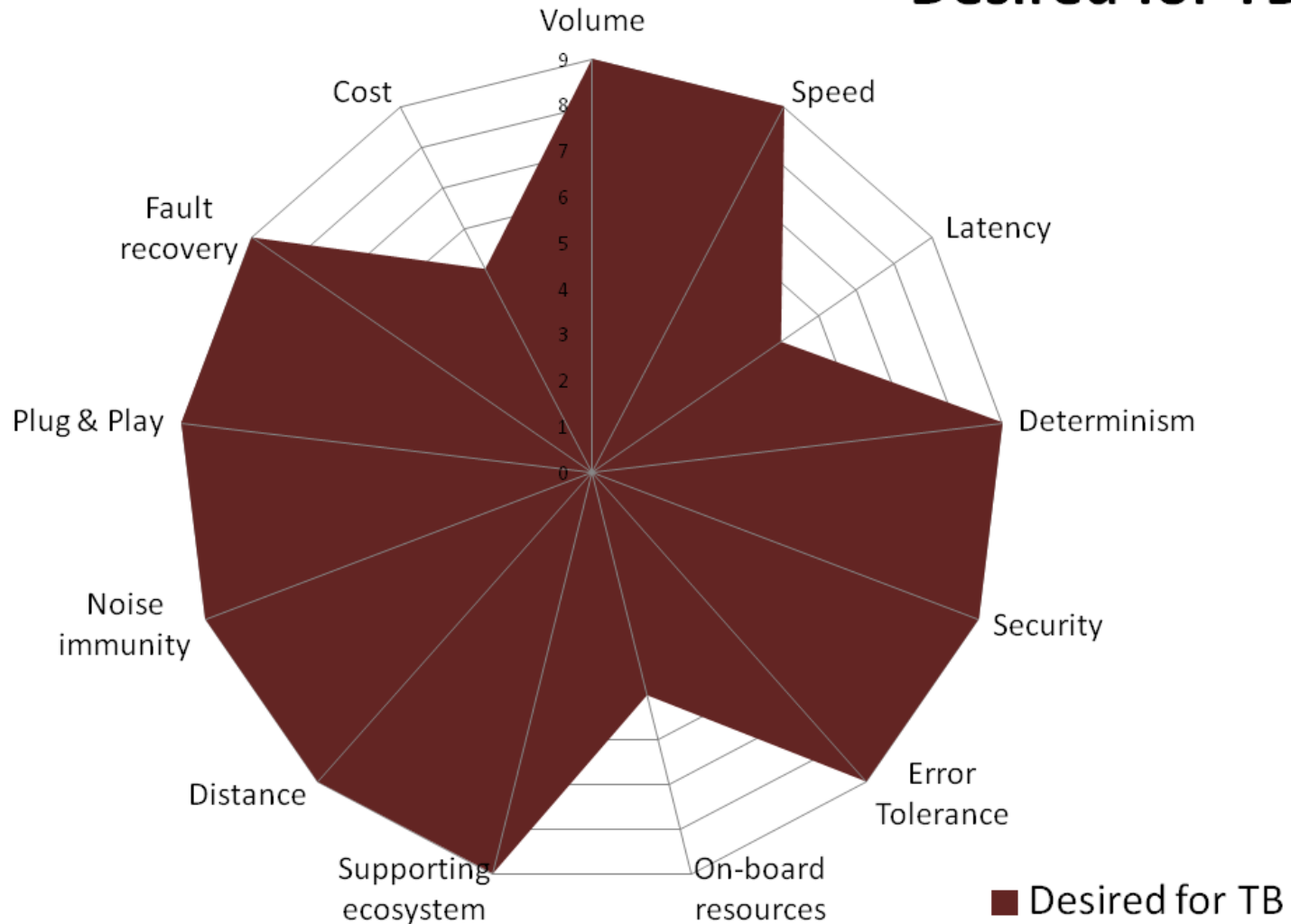
Technology Selection: Criteria for TB

Ethernet as TB

Network Architecture: Proposed

Network Architecture: Proposed

- Explore wireless for inter-vehicle connectivity

Road Map: Equipment

- Ethernet / CAN Train Bus Routers
  - Wireless inter-vehicle connections
  - Use open source software and customize
    - DD-WRT as a start point
  - Integration of TRDP
    - TCNOpen Project
- Software Stack for CAN Interfaces
  - Open source stacks available
  - Customize to handle dual CAN buses
- Design goal
  - **To free applications from communications handling**

Road Map: Conformance Testing

- Why testing facility?
  - Requirements dedicated to Indian Railways
  - Cannot expect suppliers / other labs to invest
  - All equipment to be tested at the time of integration
  - Interoperability
- How?
  - Application level testing laboratory
    - Develop standard test protocol software
    - Simulate the communication network of a 26 vehicle train

Cost!

TCN with WTB-MVB interfaces						
Veh. Type		WTB-MVB Equip.		MVB Equip.		
Type	No.	Qty./Veh.	Cost	Qty./Veh	Cost	Total
Loco	2	1	$ 5,700	30	$ 860	$ 63,000
Coach	24	1	$ 5,700	20	$ 860	$ 5,49,600
					TOTAL	$ 6,12,600

TCN with ETB-CAN interfaces						
Veh. Type		ETB Equip.		CAN Equip.		
Type	No.	Qty./Veh	Cost	Qty.	Cost	Total
Loco	2	2	$ 2,500	60	$ 50	$ 16,000
Coach	24	2	$ 2,500	40	$ 50	$ 1,68,000
					TOTAL	$ 1,84,000

Questions?

"If you are not failing every now and again, it's a sign you aren't doing anything very innovative"

~Woody Allen

Thank You!

OSI Model

	Data Unit	Layer		Function
Host Layers	Data	**7**	Application	Network process to application
		6	Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data
		5	Session	Inter-host communication
	Segments	**4**	Transport	End-to-end connections, reliability and flow control
Media Layers	Packet	**3**	Network	Path determination and logical addressing
	Frame	**2**	Data-link	Physical addressing
	Bit	**1**	Physical	Media, signal and binary transmission