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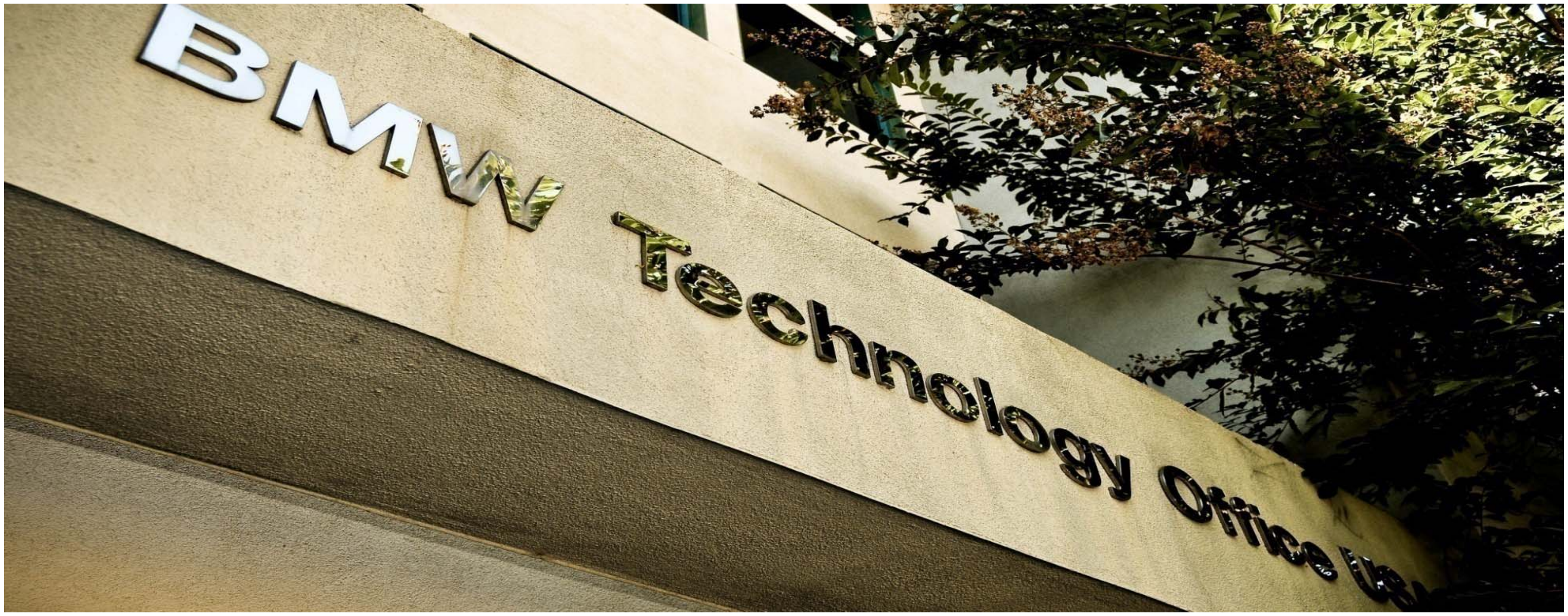
1722.1 Automotive Use Cases.

802.1 AVB in a vehicular environment.



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Current Car Bus Technologies.

Current Car Bus/Link Technologies.
LIN, CAN, and Flexray.

- LIN (19.2kBit/s) is an ultra low cost bus to do very simple things like click wheel controls (similar to UART).

- CAN (500kBit/s) is widely used to do engine and chassis control, but also to transmit simple commands to e.g. control the power window. CAN also used to be the main software programming and diagnostics bus.

- Flexray is a deterministic, time triggered bus with 10MBit/s data rate, it is used in the current/new BMW X5, 7 and 5 series.

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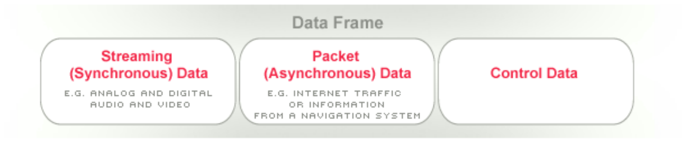
Current Car Bus/Link Technologies.
MOST – Media Oriented System Transport.

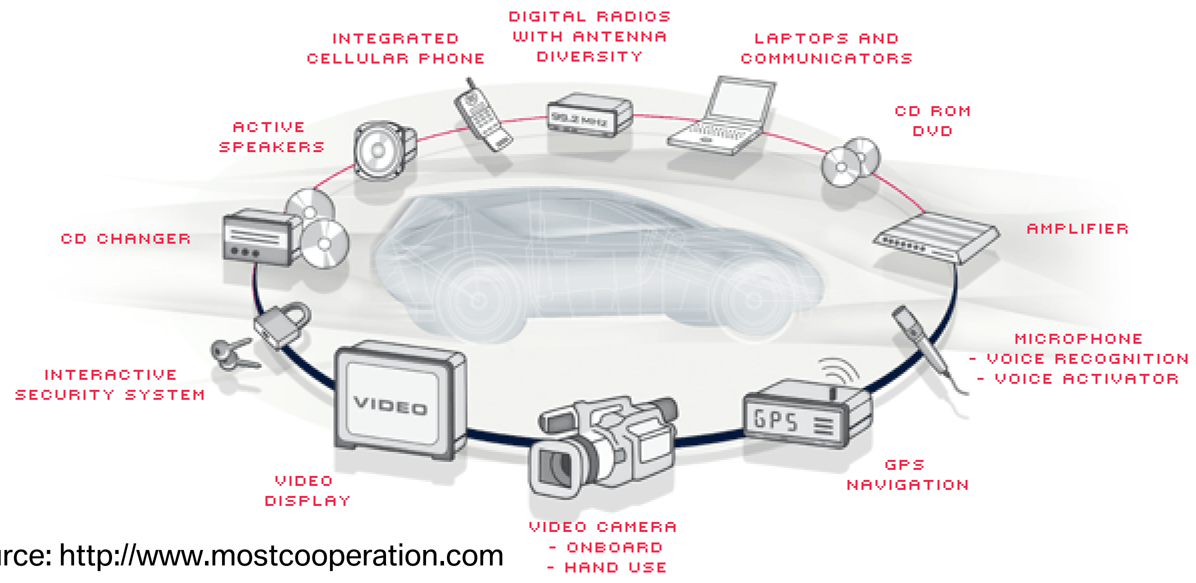
-Widely used in today's cars (BMW, Mercedes, Audi).

-MOST25 and MOST150 are optical buses, MOST50 is an electrical version.

-BMW Group uses the optical MOST25 (25MBit/sec; control + asynchronous + synchronous channels), for audio (44.1kHz) only (no video).


Data Frame
Streaming (Synchronous) Data
E.G. ANALOG AND DIGITAL AUDIO AND VIDEO
Packet (Asynchronous) Data
E.G. INTERNET TRAFFIC OR INFORMATION FROM A NAVIGATION SYSTEM
Control Data

Source: http://www.mostcooperation.com



Source: http://www.mostcooperation.com

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Current Car Bus/Link Technologies.
LVDS - Low Voltage Differential Signaling.

- Point2Point connection, no bus, no control, no protocol.

- Very high data rate (800 MBit/s, next gen 2.5 Gb).

- Uncompressed transmission of data (e.g. video).

- EMC requires shielded cable, high cost factor!

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Today’s and Future Ethernet Use Cases.

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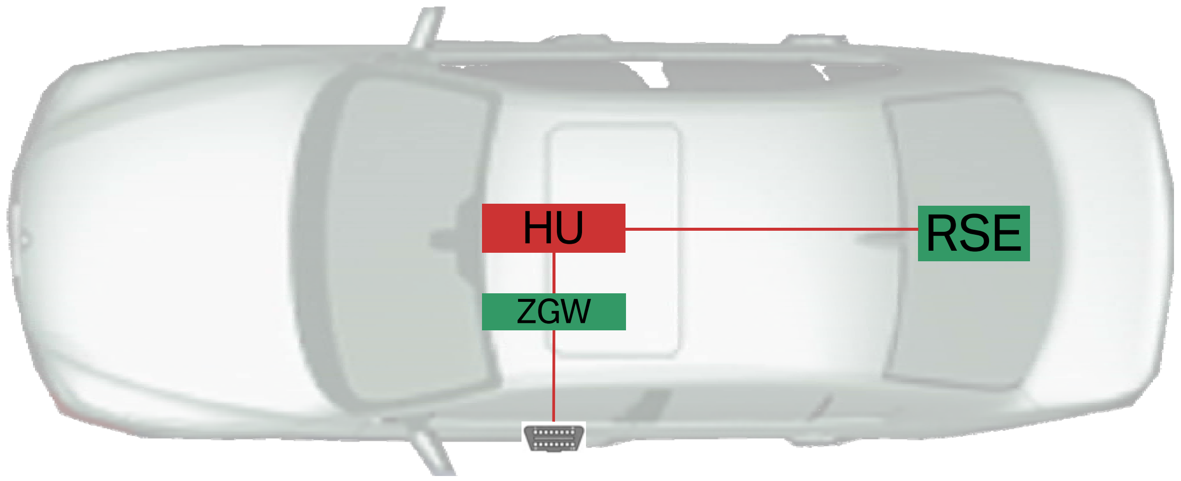
Today's Ethernet Use Cases.
Programming & Diagnostics access.



- ZGW (Central Gateway) distributes data to multiple CANs and MOST.

- HeadUnit (HU) can update HDD via Web-Access.

- Connection HU/RSE uses shielded cable due to EMC.

- First introduced in new BMW 7 series.

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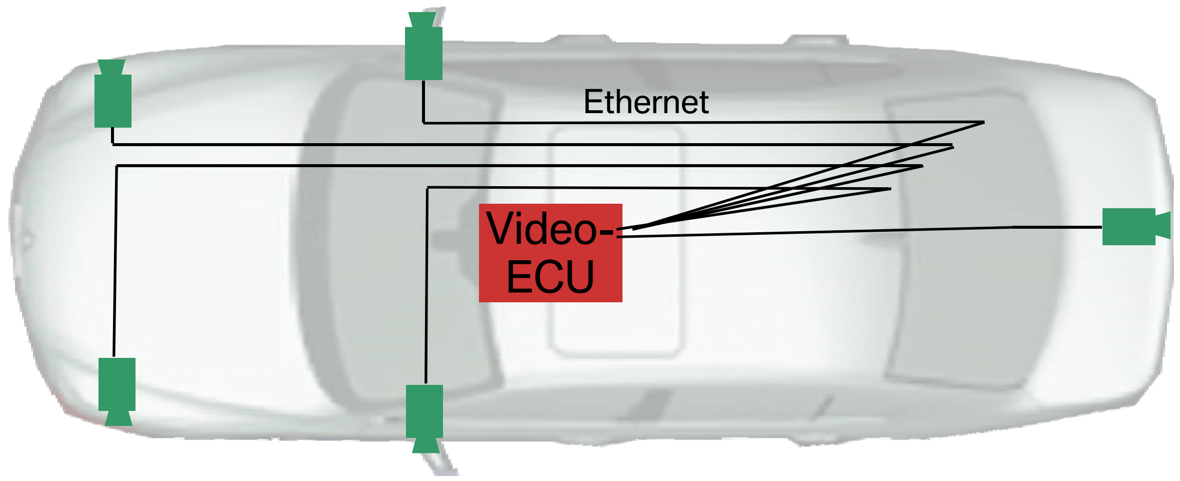
Future Ethernet Use Cases.

Camera systems.



- **This is just an example how a system could look like!**

- Cameras act as a talkers.

- An image processing device in the car acts as the listener.

- Static system.

- Cost saving – uses unshielded cable.

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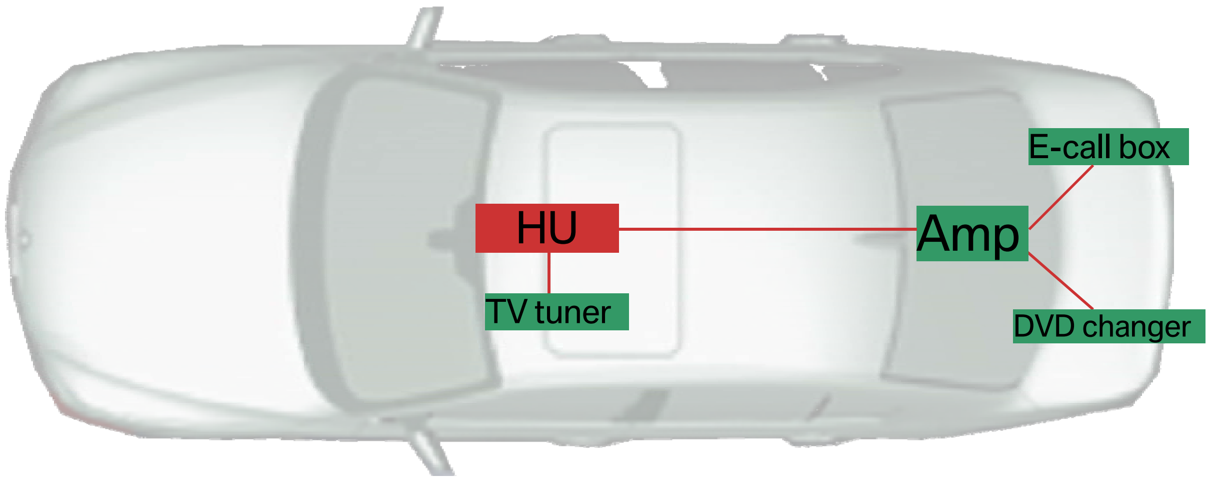
Future Ethernet Use Cases.

Entertainment system.



- **This is just an example how a system could look like!**

-Some devices are talkers, some listeners, some both.

-Semi-static system: TV, DVD are options.

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Key Requirements & Assumptions.

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Key Requirements & Assumptions.
What we need.

• We need a standards based approach to allow interoperability of multiple vendors on one network.

• We want to move as close as possible towards standard industry solutions.

• We don't need the latest and greatest - the goal is to simplify current systems at a lower price point.

• Our wide range of control units (very small embedded devices all the way up to PC-like Head Units) requires a very scalable solution.

• We need a robust, predictable, decentralized system that scales well and is easy to monitor.

• Our very long lifecycles (3 yrs development + 6-7 yrs car production time frame + 15 yrs spare parts) require a rock solid strategy aimed at backwards compatibility.

• Network functions must be easy to implement for "everyone".

We look for (Guy Fedorkow at a 1722.1 meeting)*:*
"Standardized application-specific and device-specific configuration isn't a requirement… Just get the streams to flow…"

Key Requirements & Assumptions.
Specific statements.

• Controllers, Talker and Listeners are in the same administrative domain.

• We want to use IP traffic to access a device for control, but transport streams on Layer 2.

• We have a maximum of 20 nodes in a single system.

• We have a maximum of no more than 25 simultaneous streams at any one time.

• We don’t need different application-priorities for streams.

• Our system requires at least one – maybe slim – system configuration controller.

• The connection control shall not require a centralized instance.

• Management of streams will be handled by upper layer applications.

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Key Requirements & Assumptions.
Continued.

• The system has to start up and recover quickly.

• We need quick connection built up (and tear down) – early audio and video!

• We need fast discovery and enumeration – or none at all.

• Consumer gear plug in scenarios are outside our scope today, but maybe interesting in the far future.

• Access to configure the car through the web (VPN) is out of scope for this work.

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Use Case Example.

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Use Case Example.
Startup - what can run in parallel?

time

PHY link up: With auto-negotiation or **without auto-negotiation**			
Obtain IP address: **Pre-assign static IP** or AutoIP	Start Best Master Clock Algorithm or **fixed Grand Master** 1st hop – nth hop	**PTP PDelay** 1st hop – nth hop	**Multicast Address Assignment** **Pre-assign** or negotiate via MAAP
Run MDNS and DNSSD For Service Discovery (parts of ZeroConf)	**PTP Sync.** 1st hop – nth hop		**MSRP Talker Advertise** 1st hop – nth hop (do we need the dest. MAC addresses for that?)
Enumeration Via AV/C or RPC or **known to higher layers**	**Send/Receive n PTP messages** as required by clock recovery algorithm		
Set up a connection with e.g. Google Protocol Buffers and RPC or AV/C			
			MSRP Reservation Request/Registration 1st hop – nth hop
			Start 1722 streaming
Control the stream output with e.g. Google Protocol Buffers/ RPC or AV/C			**Send/Receive streaming packets**

Use Case Example.
Startup Worst Case.

- Driver sleeps in the car.
- All ECUs are powered off.
- Driver wakes up and cranks the car without opening a door/unlocking the car.
- The Park Distance Control warning sound must be audible in less than 2 seconds after cold start.
- The rear-view camera must be visible in less than 2 seconds after cold start .

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Proposals and Questions.

Proposals and Questions.

A. How devices talk.

B. Serialization w/ Google Protocol Buffers.

C. Zeroconf for Discovery.

D. Small devices.

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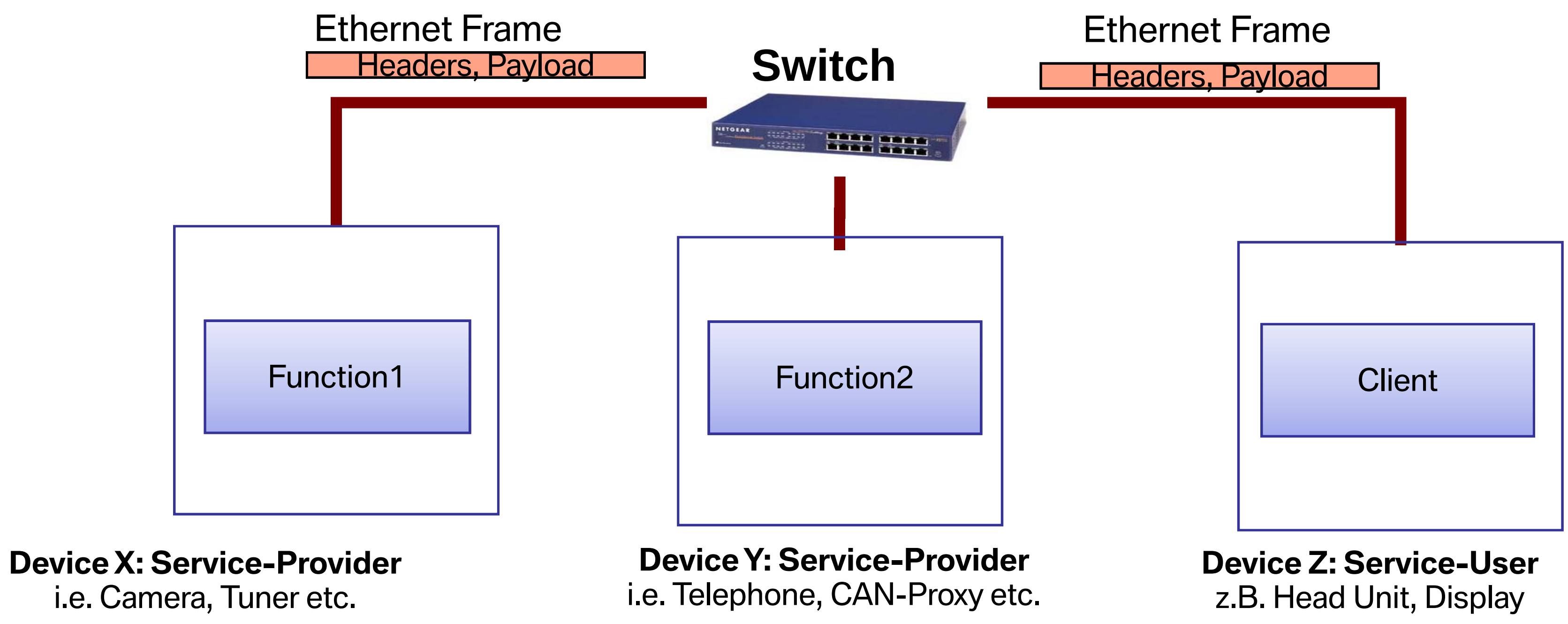
Proposals and Questions.
How devices talk.



Questions:
- Q: How do devices discover each other? (A: ZeroConf?)
- Q: How to address a remote service?
- Q: How to transmit the functional data on the bus?
- Q: How to keep the interfaces compatible?
- Q: Who manages the switch?
- etc.

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Proposals and Questions.
Serialization w/ Google Protocol Buffers.

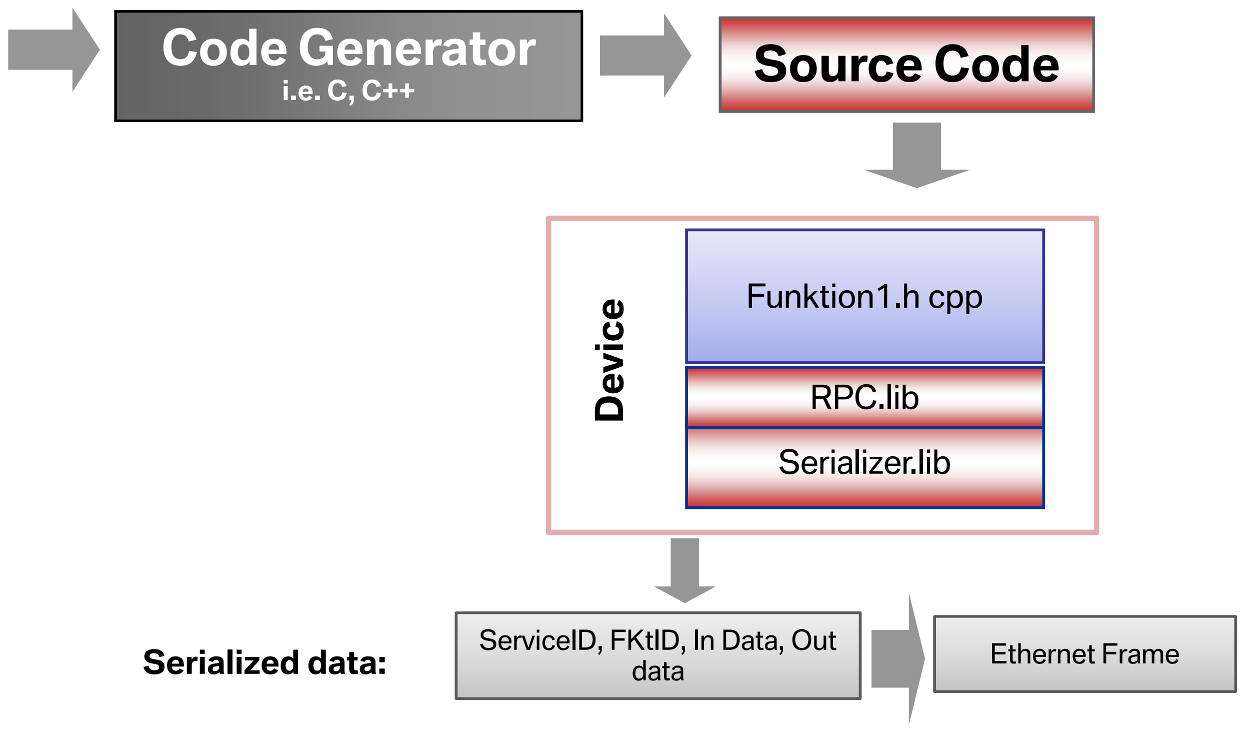
Advantages:
- Very efficient serialization (binary, optional parameters possible).
- Compatibility can be maintained.
- Software tool chain is available for free (code generators).
- Scalable design possibilities and efficiently generated code.

Camera.proto

```
package bmw.fas

Service Camera
{
Rpc ConfigureCamera
(ConfigureCameraData) returns
(ConfigureCameraData);
..
}

Message ConfigureCameraData
{
optional float frame_rate =1;
optional FrameRateData
frame_rate2 = 2;
repeated bmw.vng.rpc.RpcError
errors = 3;
..
}
..
```



Serialized data:

Proposals and Questions.
Zeroconf for Discovery.

What it does for us:
• Translate between names and IP addresses without a DNS server (Multicast DNS)
• Find services, like printers, without a directory server (DNS Service Discovery)

Advantages:
• Decentralized approach.
• Robust and simple.
• Scalable.
• Widely adopted and free.
• Reference implementations available.

Open Questions:
• Use un-cached mode to save memory?
• No text records to save memory?
• Do we need host names or just use fixed IP addresses?

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Proposals and Questions.
Small devices.

Example: Sensor device with 40-60kB RAM like a camera or a microphone.

Open Questions:
- How to avoid dropping UDP frames due to input buffer overflow in systems using static memory allocation?
- How to ensure the message delivery?
- How to restore message sequences?
- How to deal with bursts (e.g. startup or network recovery)?

Ideas:
- Not always allocating memory for the full MTU size per UDP frame.
- Higher layers have to detect message loss and to initiate a retransmit.
- Sequence numbers for messages.
- Multiple command queuing.
- TCP was designed for reliable transmission of large volumes of data.

Conclusion:
We currently believe in using UDP with a simple reliability mechanism on top.