SDR for Motor Vehicles

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Software Defined Radio (SDR)

Hardware Radio

Separate devices for different functions

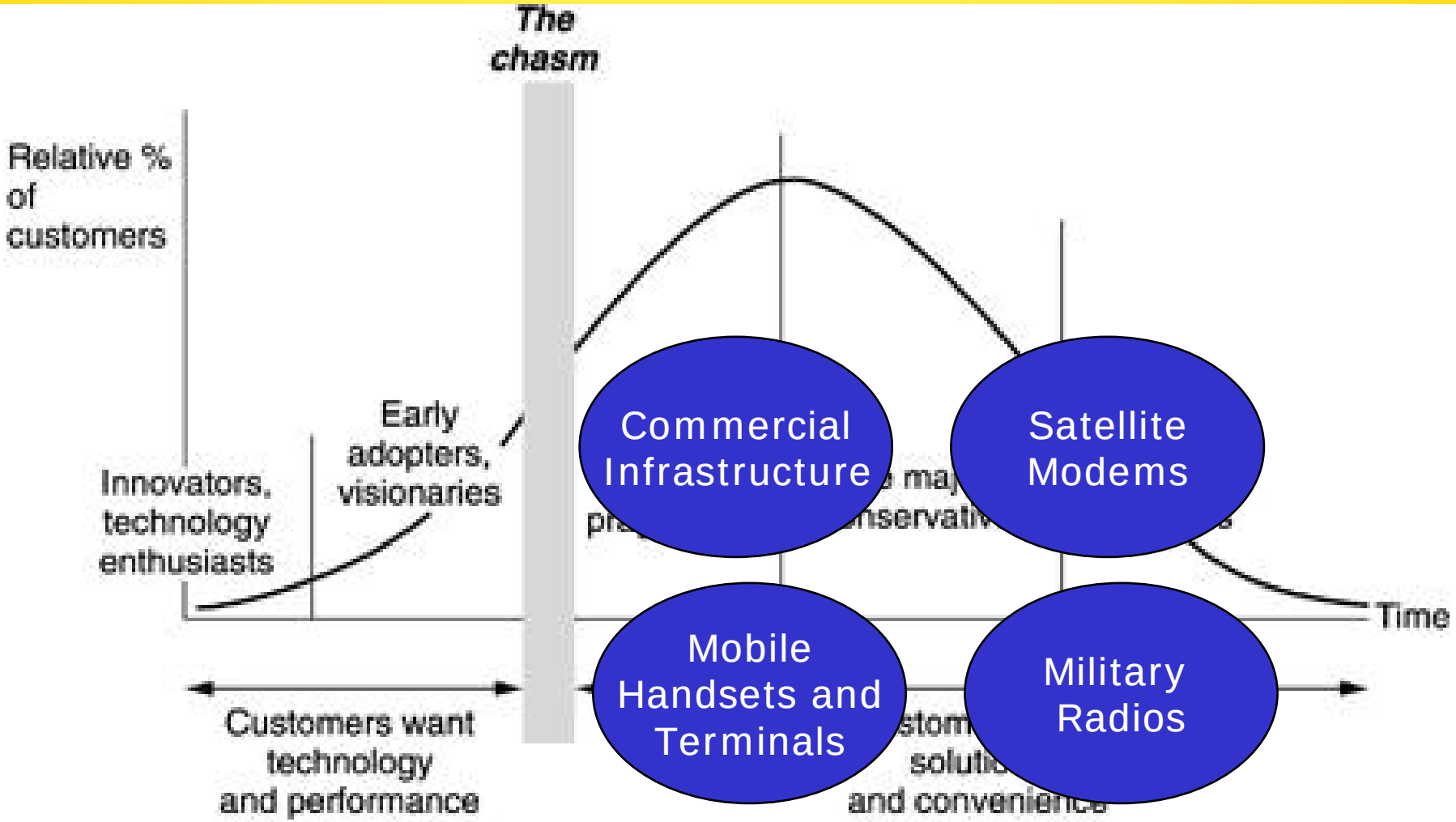
Communications function fixed in hardware

Software Radio

One device for many functions

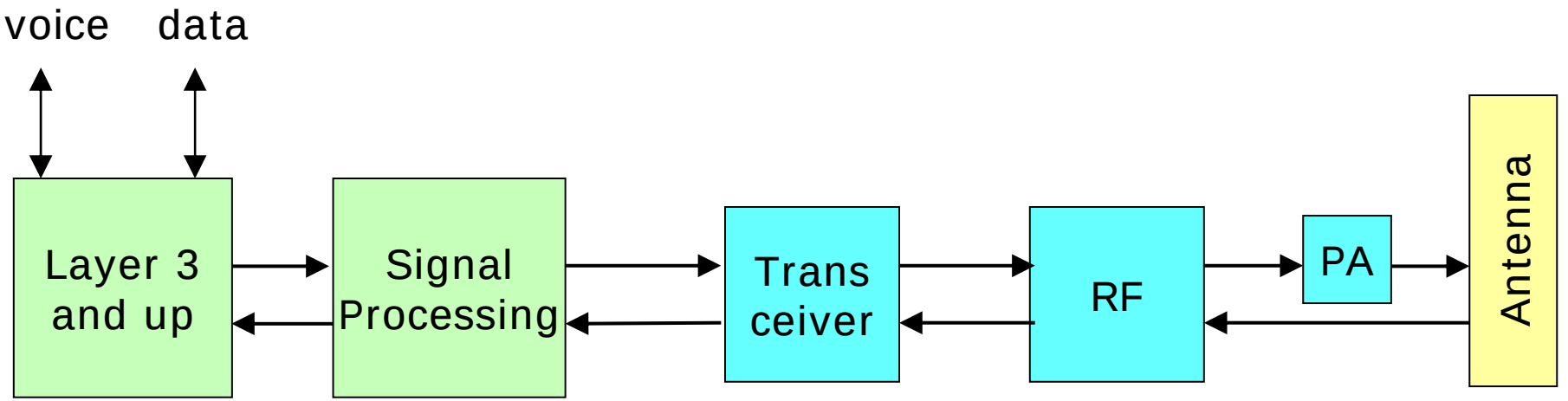
Modify through software

Market status of SDR

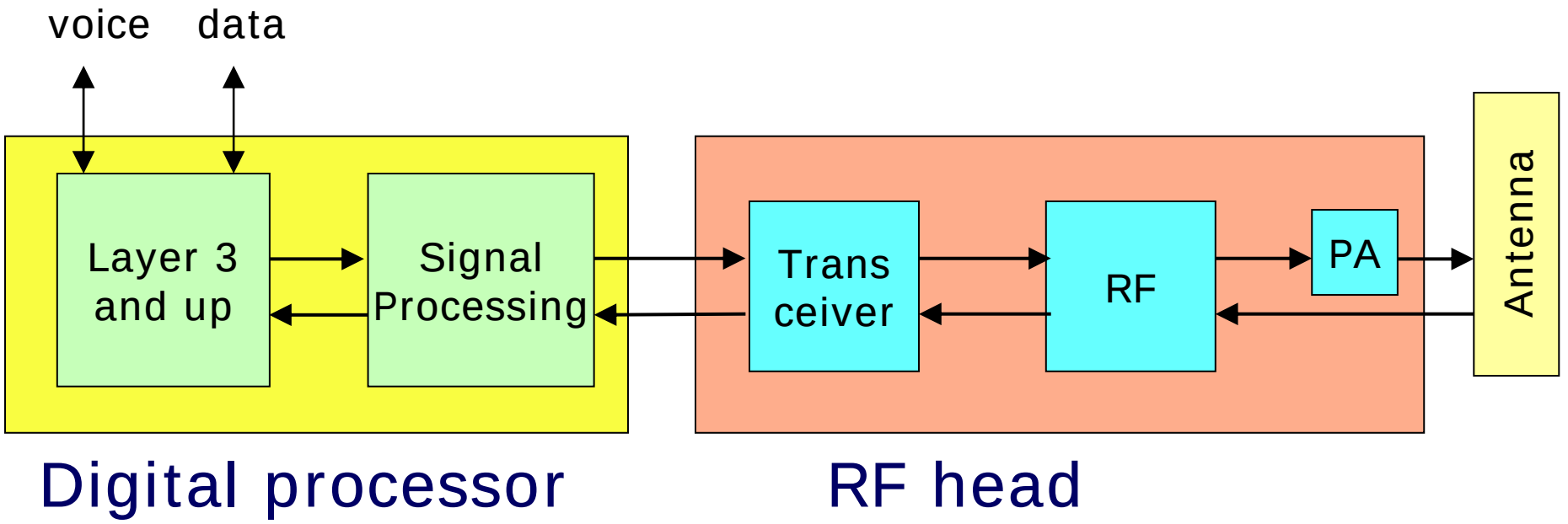


Source: SDR Forum and http://mitpress.mit.edu/books/NORVH/2-3.jpg

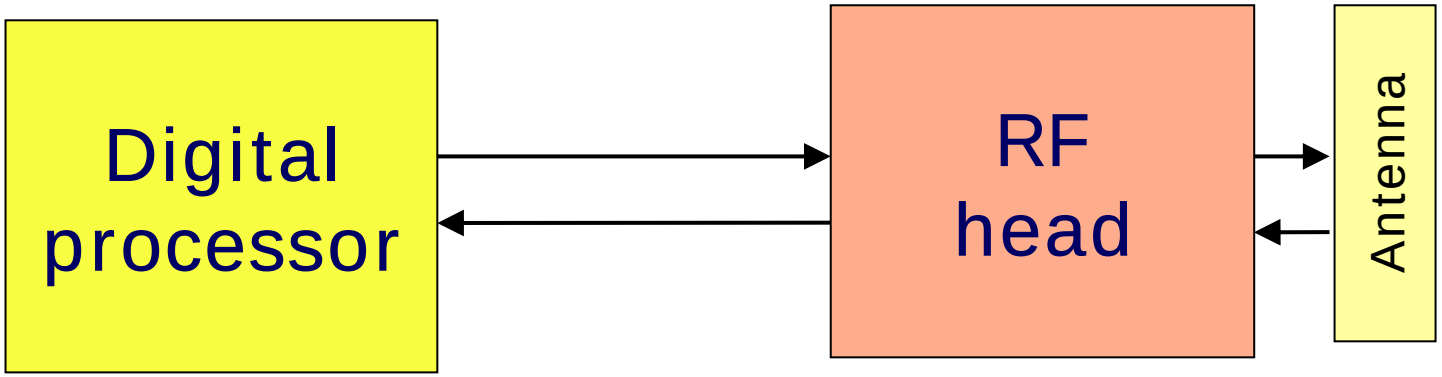
SDR Architecture



SDR Architecture



Terms for SDR capabilities



Waveform flexibility

Device supports multiple communications standards

Implemented by software in the digital processor

Constrained by: RF head

Frequency agility

Device supports multiple transmission bands

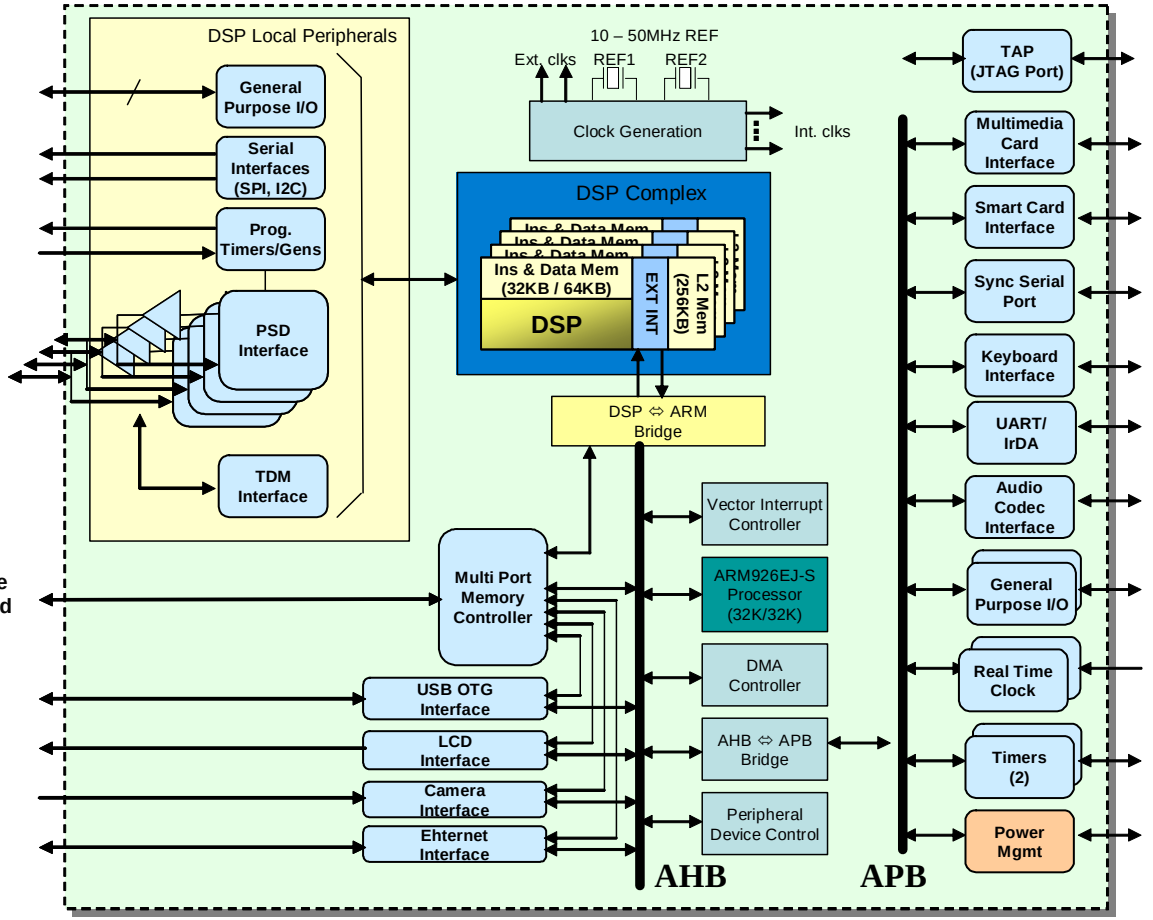
Implemented by tunable components in the RF head

Broadband antenna

Maturity of SDR Capabilties

- Waveform flexibility
  - Mature, in wide commercial use
  - Recent processors are fast enough to run WiMax and 3G LTE at low cost and low power
- Frequency agility
  - Not mature for commercial use
  - Challenges: tunable filters and amplifiers
    broadband antennas
  - Multiband radios today are actually multiple radios built into one package
    - this is good enough for many applications

Flexible Baseband Processor (SB3011)



- Multiprotocol
  - WCDMA
  - CDMA-2000
  - TD-SCDMA
- Quad Core DSP
- ARM926 GPP
- Hardware Accelerators

Motivations for SDR in Vehicles

- Life cycle mismatch
  - SDR devices are upgradable
- Global requirements variation
  - SDR devices are specializable
- Many radios in vehicle
  - SDR devices are multimode

Motivation #1 for SDR in Vehicles

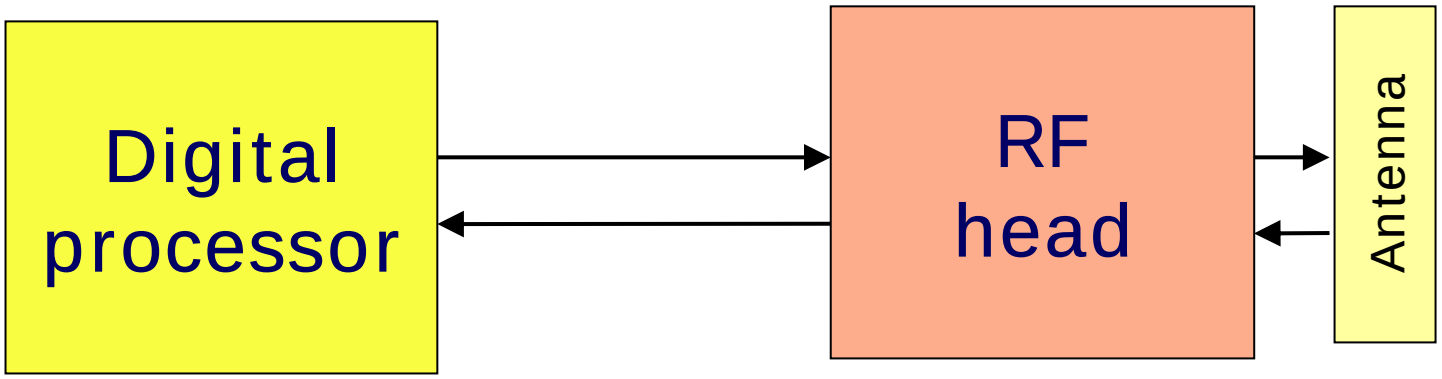
- Life cycle mismatch
  - Wireless standards change ~ 18months
  - Vehicle design cycle ~36 months
  - Vehicle lifetime ~120 months

- SDR devices are upgradable
  - reduce risk over design cycle
  - improve customer satisfaction over lifetime

Commercial status of upgradable SDR

- Modal SDR
  - Limited to modes planned at design time
  - Widely used in high-end mobile devices
- Reconfigurable SDR
  - Can add unforseen communications standards
  - Commercially deployed in infrastructure
    - e.g. Vanu Anywave cellular base stations
- Caveat: limited agility

Reasons that many SDRs are modal



ASIC co-processors to accelerate complex tasks

Data path designed for specific processing stages

Recent processors no longer need these specializations

Save cost and power by designing for waveform, eg:

- Bandwidth
- Peak-to-average power
- A/D sync to chip timing

Still important with current technology

Motivation #2 for SDR in Vehicles

- Global requirements variation
  - Wireless standards vary by region
  - Different hardware per region adds cost
- SDR devices are specializable
  - Single hardware unit
  - Load SDR software at point in supply chain where vehicle's destination is known
  - Even at dealership (based on customer-purchased options)

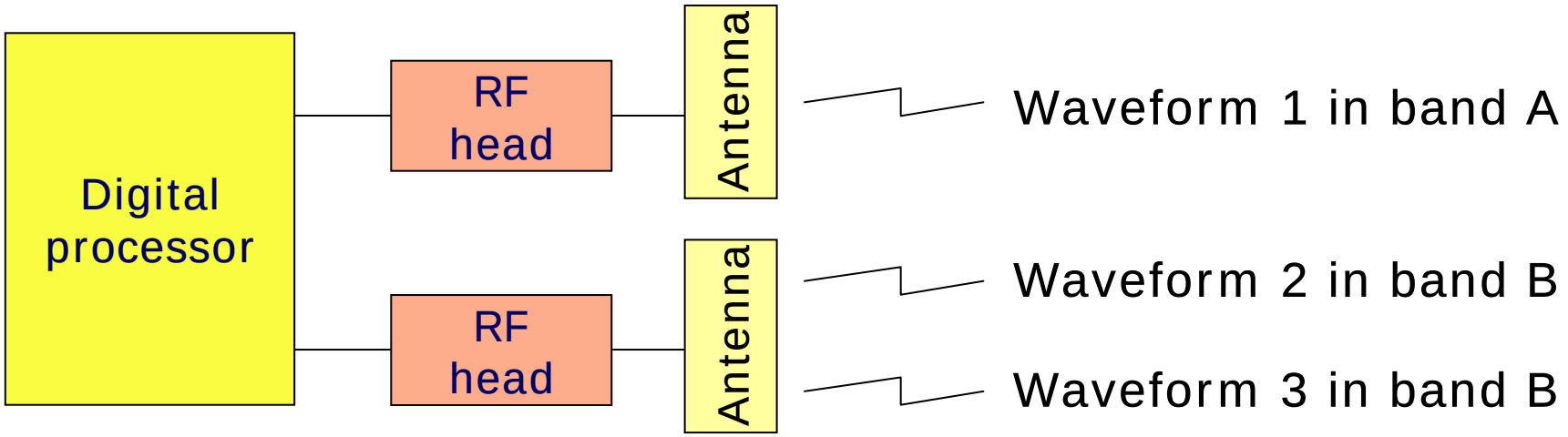
Commercial status of specializable SDR

- Ready for vehicles
  - Modal SDR is sufficient for this application
  - Must design band plan in advance due to limited frequency agility
  - Can easily achieve most of the potential benefits

Motivation #3 for SDR in Vehicles

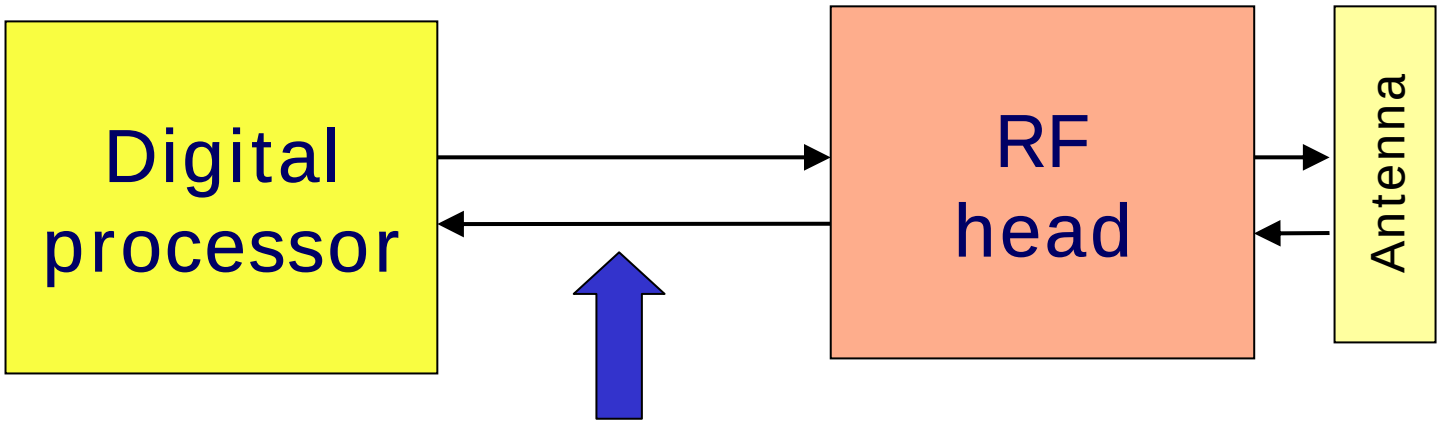
- Many radios in vehicle
  - Analog audio, digital audio, satellite, internet, tolls, keys, concierge, tracking, radar, …
  - Separate components for each adds cost
- SDR benefit: multimode
  - Single baseband processor for many radios
  - Can be sized to run N of M waveforms simultaneously
  - Antenna sharing reduces holes in vehicle

Commercial status of Multimode SDR



- Widely used in line-powered systems
  - Satellite communications, broadcast, cellular infrastructure
- Not widely used yet in mobiles
  - No technical barrier for mobiles or vehicles

Key Recommendation for Automotive SDR



- Select an open standard for "Digital IF"
  - Plug-and-play RF heads
  - Common software across family of radios
  - Evolve digital and analog components independently
  - Enable multimode / distributed architectures

Standards issues in Digital IF

- Existing standards not appropriate
  - OBSAI, CPRI : for large-scale infrastructure
  - DigRF : for tightly integrated handhelds
  - Physical link must meet automotive reqts
- Components of a standard
  - IF data, timing : relatively easy
  - RF head config/control : challenging
- Opportunity
  - SDR Forum is working on the config/control API
  - Invitation to automotive industry to shape SDRF standards effort to meet your needs

Summary

- SDR is ready today for automotive use
  - High waveform flexibility
  - Limited frequency agility
  - Key benefits: upgradeable, specializable, multimodal
- Recommend selecting an open Digital IF standard for autos
- SDR Forum is exploring ITS and automotive applications – please join us!
- Thank you for your attention

BACKUP SLIDES

Vanu, Inc.

- Founded in 1998, MIT spin-off
- Product / Market
  - Anywave™: Cellular infrastructure for rural areas and emerging markets
- Recognitions:
  - 2007 IEEE Spectrum Magazine “Wireless Winner”
  - 2005 GSM Association Technology Award for Most Innovative Infrastructure
  - 2005 SDR Forum Industry Achievement Award
  - 2004 World Economic Forum Technology Pioneer

The SDR Forum

Promoting the success of next generation radio technologies

- Focus
  - SDR and cognitive radio for all applications of wireless systems
- Membership
  - Industry / government / academic
  - Approximately 100 members, worldwide
- Activities
  - Advocacy, opportunity development, commercialization, and education