# An IC Manufacturer's Perspective on Digital TV

Digital Broadcast Issues

Product History

Technology

Outlook

**Oren**

# The Wireless Problem

Problem:
Wireless broadcast signal robustness and coverage area depends on noise, reflections, weather and terrain effects.

Oren

# Product History

▶ **1998** - Digital demodulators

  ➢ Introduced Oren's first 8-VSB digital TV demodulator according to ATSC

  ➢ Oren OR51210 8-VSB demodulator is recognized as a top competitor at ATTC

  ➢ For HD set-tops, Satellite/HD, iDTV, PC add-in cards, and datacasting applications

▶ **1997** - Analog ghost canceling

  ➢ Applied filtering and equalizer to analog multi-path image processing

  ➢ Cross Licensing of Patents with Philips

  ➢ Currently shipping fourth generation to all major Japanese TV manufacturers

▶ **1995** - Digital filter, DSP, and equalizer technology

  ▶ Company founded on auto-tracking technology for military applications

•**Total of 11 patents granted or pending**
•**All algorithms and VLSI developed in-house**

*Oren*

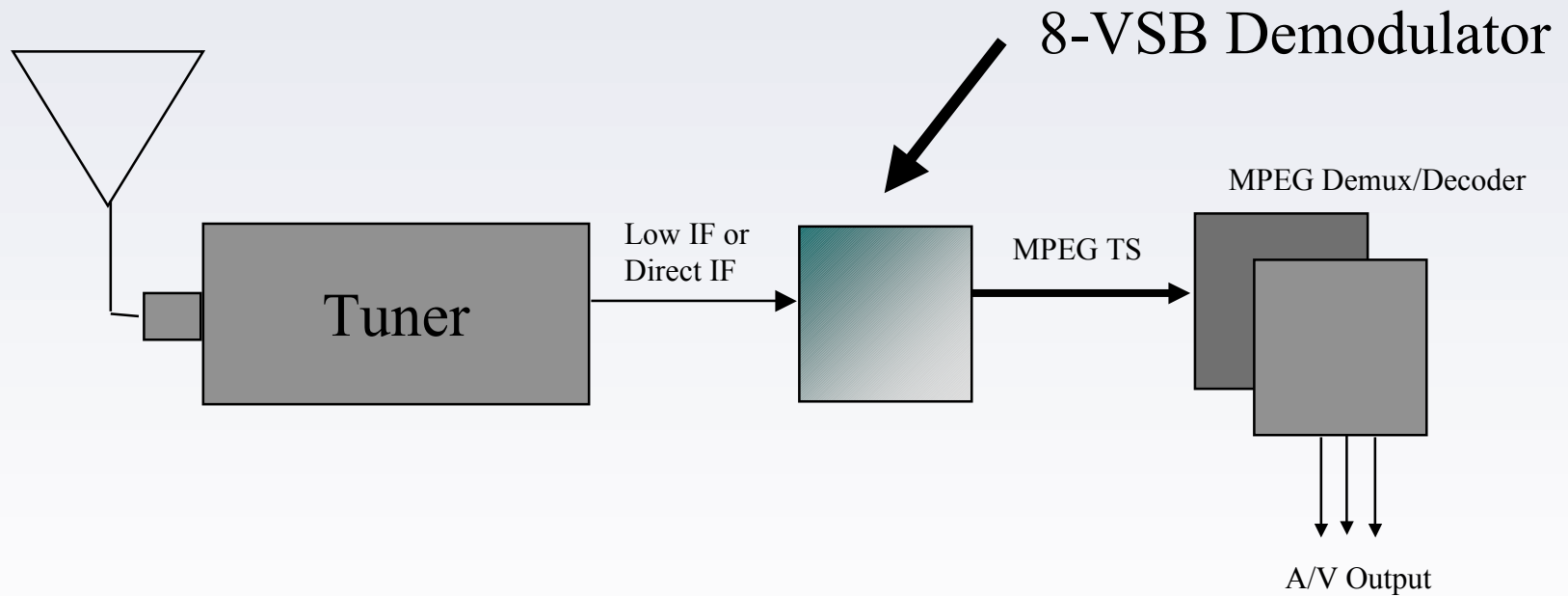# Basic VSB demodulation

▶ Known Series of digital bits used to 'train' the chip

▶ In strong multipath, blind or predictive equalization used to train the chip

▶ Equalizer acts like a Taylor series multiplier, iterating coefficients toward a final solution using an LMS algorithm

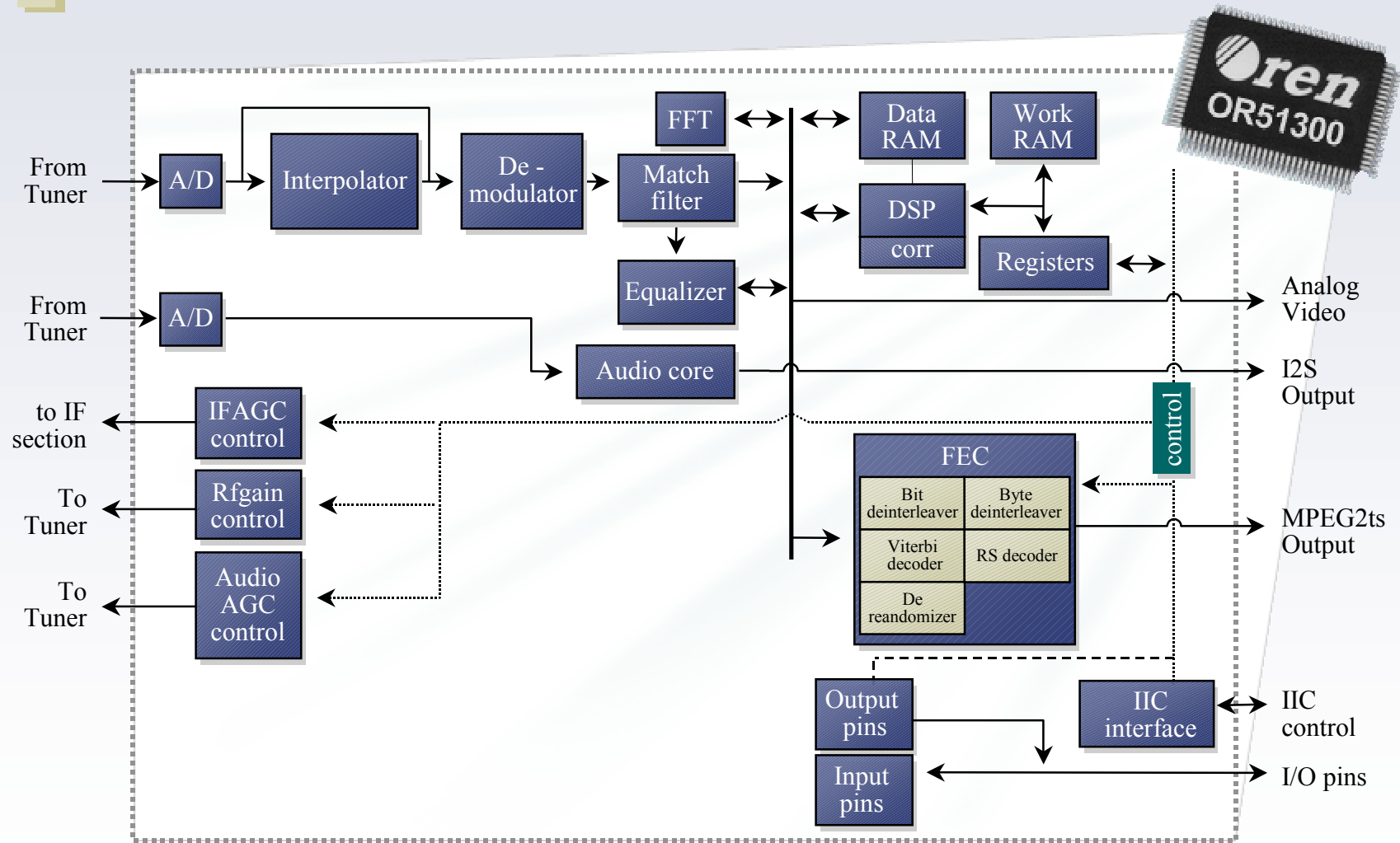▶ Data is deinterleaved and further corrected in the Forward Error Correction Circuitry

# Demodulation Technology

▶ 8-VSB IF in and MPEG-2 Transport out

8-VSB Demodulator

Tuner

Low IF or
Direct IF

MPEG TS

MPEG Demux/Decoder

A/V Output

Oren

# Block Diagram



From Tuner → A/D → Interpolator → De - modulator → Match filter

FFT

Data RAM · Work RAM

DSP corr

Registers

Equalizer

From Tuner → A/D

Audio core

to IF section ← IFAGC control

To Tuner ← Rfgain control

To Tuner ← Audio AGC control

Analog Video

I2S Output

control

FEC
- Bit deinterleaver · Byte deinterleaver
- Viterbi decoder · RS decoder
- De reandomizer

MPEG2ts Output

Output pins

Input pins

IIC interface

IIC control

I/O pins

Oren OR51300

Oren

# Integrated Circuit Development Team

▶ **Marketing:** Interviews Customers to understand high level requirements. Work with system engineering on spec.

▶ **Systems Engineering:** Have knowledge of entire system, including transmitter side. Generate top level spec for chip. Involved in Field testing the device

▶ **Algorithms:** Write code that runs IC. Have knowledge of the various communications schemes..QAM, VSB, COFDM

▶ **VLSI Engineering:** In charge of circuit design and simulation inside the IC itself.

▶ **Hardware Engineers:** Develop circuit schematics that connect the chip to surrounding ICs

▶ **Product Engineering:** Develop test programs and life tests

*Oren*
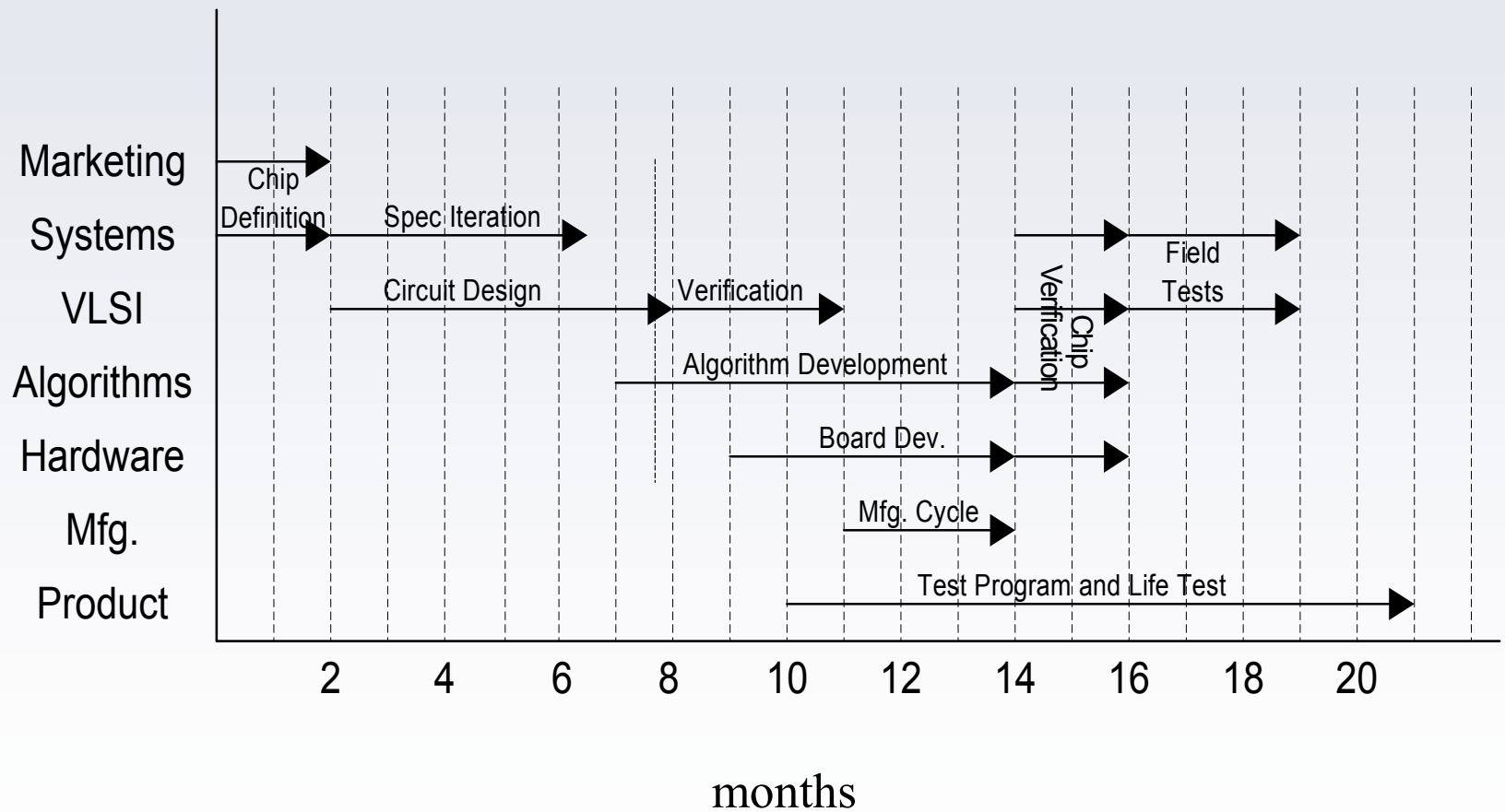
# Design Flow

# Summary of Design Flow

1) Marketing and Systems Engineering Develop Product Spec

2) VLSI Engineering generates actual IC from this spec

3) Hardware Engineering develops a board for the IC

4) Algorithms generate the 'software' that drives the IC

5) Systems Engineering takes the board and software for test

- Lab testing against ATTC benchmarks
- Field testing both indoor and outdoor
- Alpha Customer Testing

6) Product Engineering puts the chip into production

*Oren*

# Integration Development of "Cascade"

## Cascade OR51300 series demodulators for:

| | |
|---|---|
| ATSC: | 8-VSB (with FFT enhanced performance) |
| DVB-T: | COFDM (2k and 8k hierarchical) |
| Cable: | 64/256-QAM (ITU-T j.83 Annex A/B/C) |
| DVB-S/DSS: | QPSK (Satellite) |
| Analog Video: | NTSC/PAL/SECAM demodulation |

Adds ClearCast ghost cancellation to analog video output

| | |
|---|---|
| Analog Audio: | NTSC/PAL/SECAM demodulation |

NTSC audio is also decoded by OR51300, eliminating the
need for a discrete BTSC decoder for mono, stereo, SAP, dBx

## Process: 0.18μ, 5M, 3P TSMC
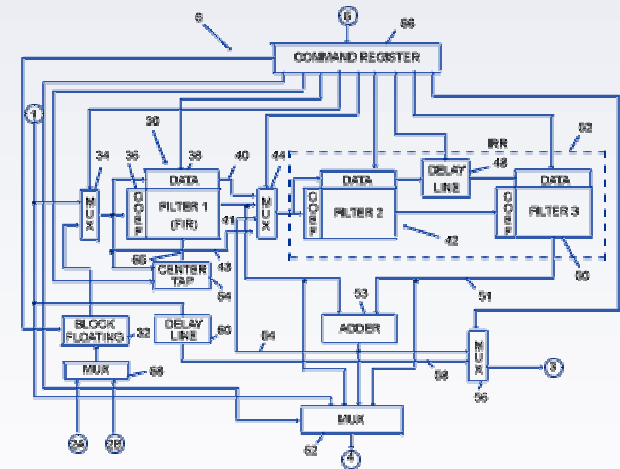
**Oren**

# Simplified Front End Design
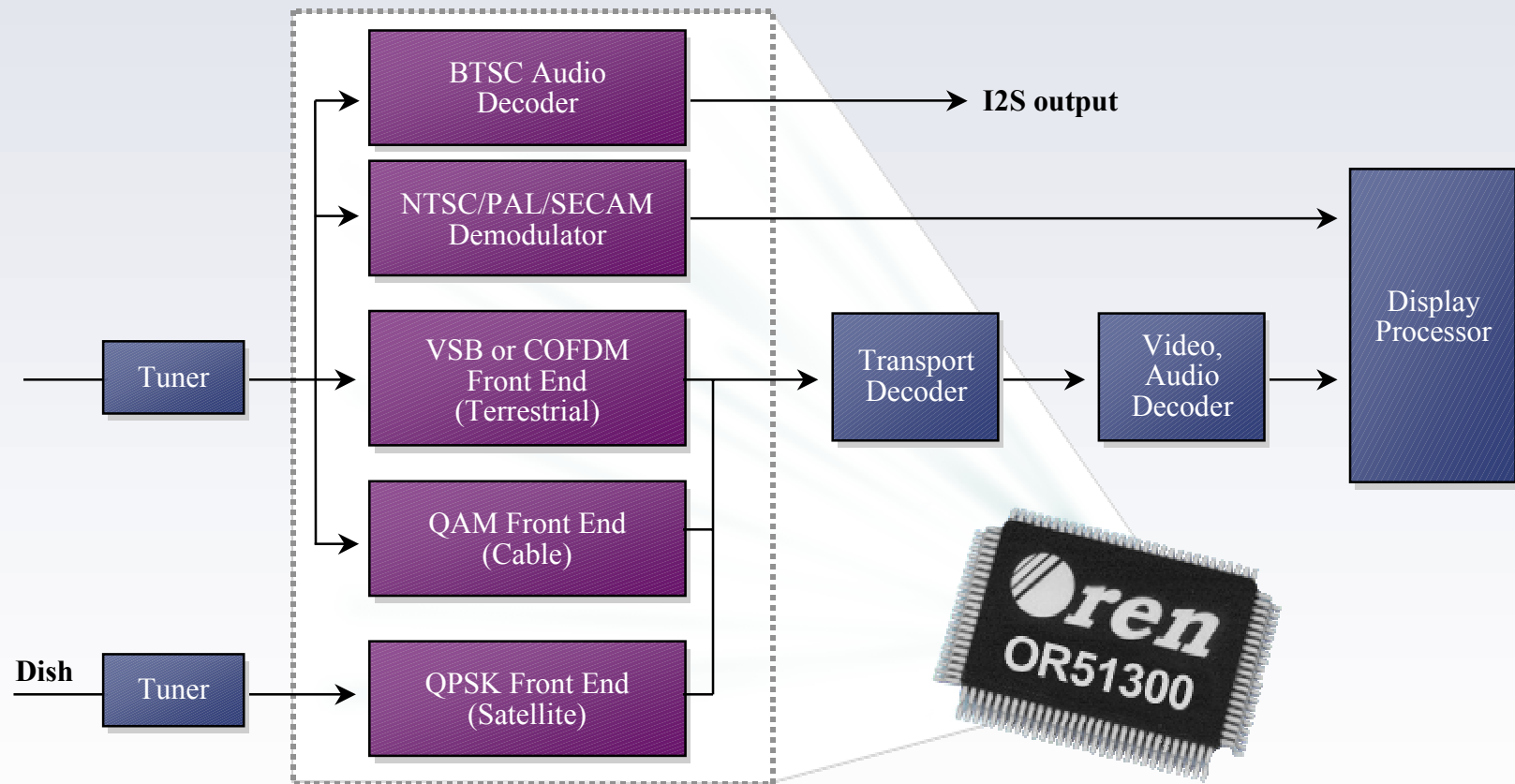


*Oren Cascade replaces five chips*

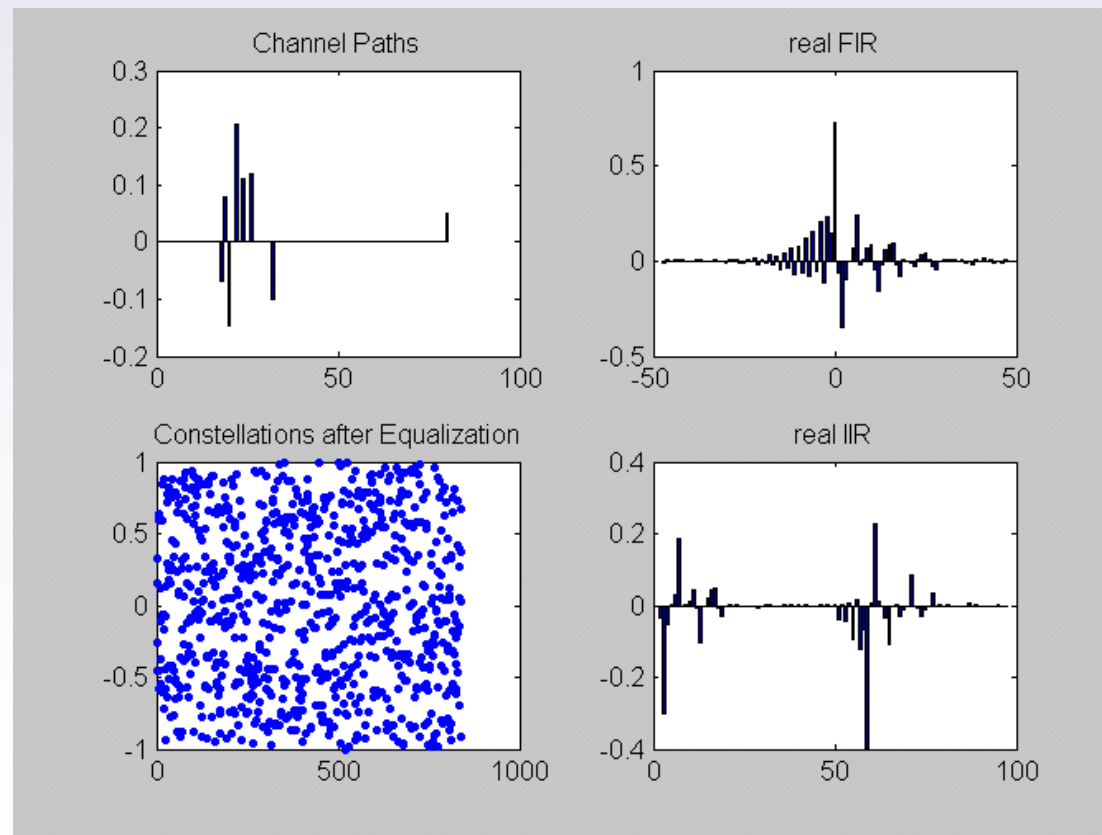# Cascade <u>Patented</u> VSB Enhancement

▸ Use of FFT enables improvements in VSB performance

▸ Replaces current LMS algorithm

▸ FFT allows:

  ▸ Real time channel snapshot

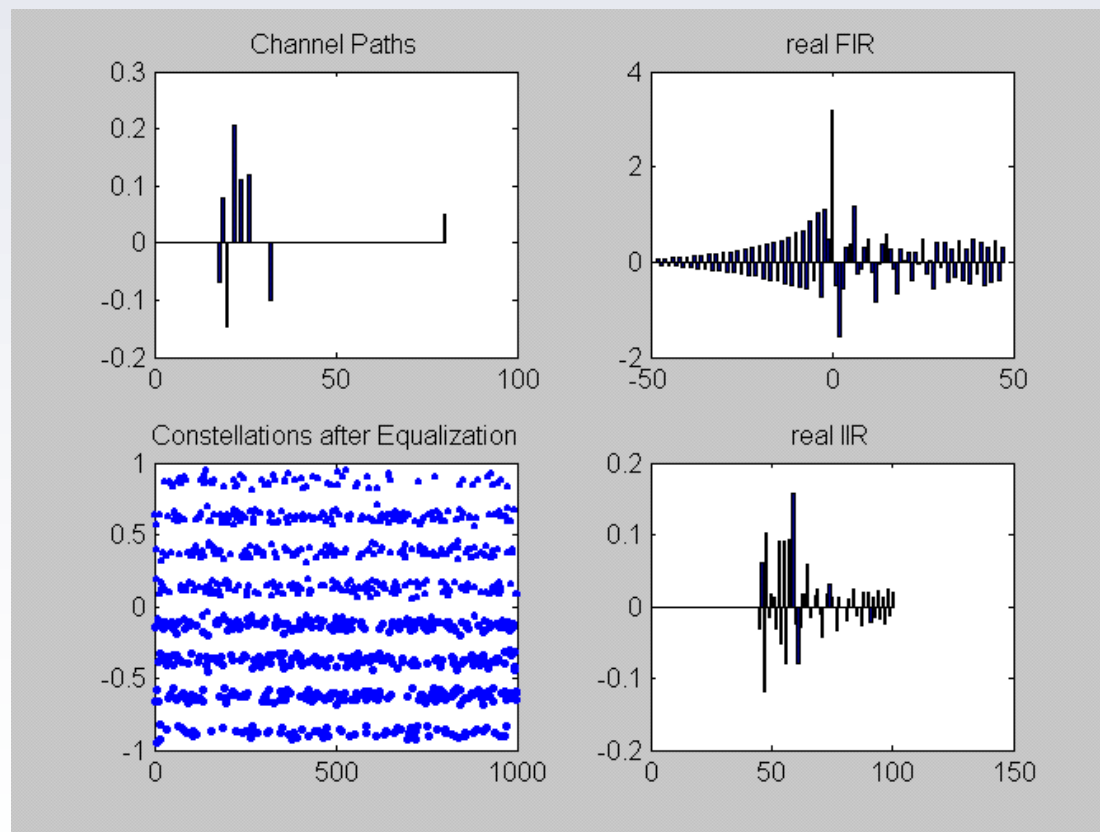  ▸ Dynamic allocation of FIR and IIR filter taps

  ▸ Accurate channel model

# FFT Hardware Benefits

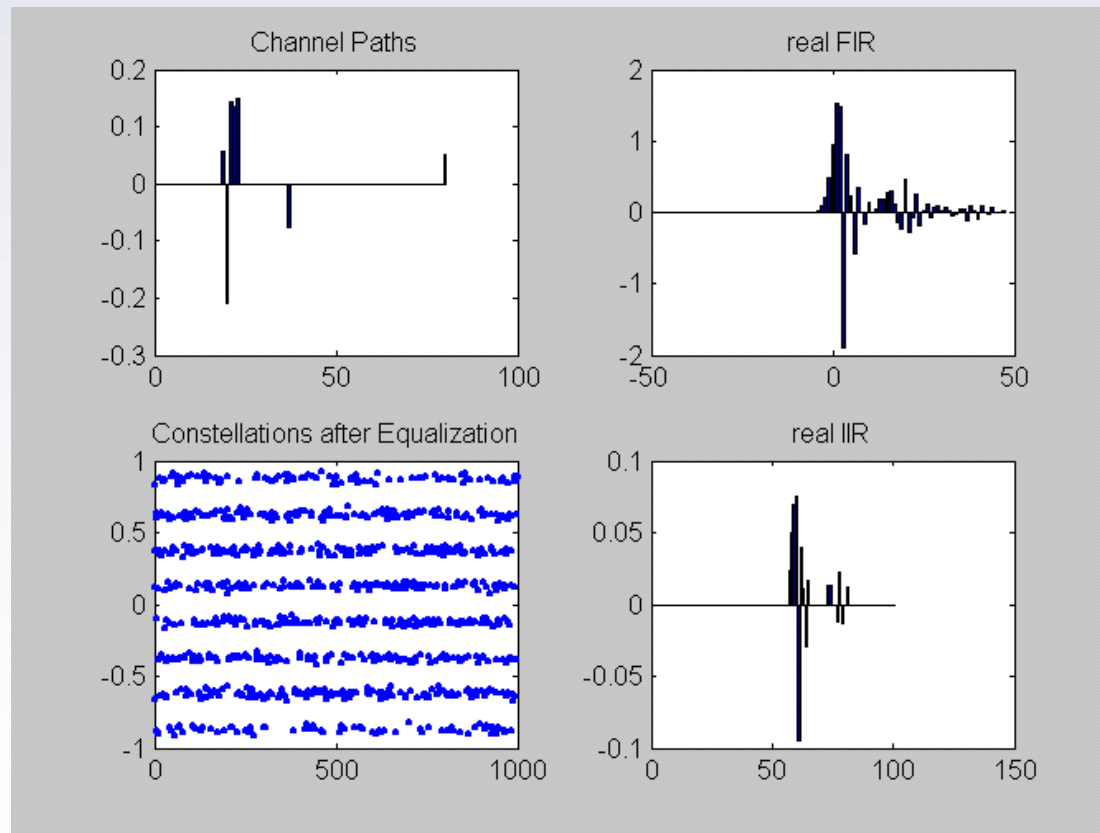▶ **Strong short ghosts with traditional receiver "LMS" equalization**

# FFT Enhancement

▶ Same test with FFT equalization

# FFT Enhancement

▶ Case 2: traditional receiver failed to lock, but achieved great performance with FFT equalizer (see notes)

# Summary

▶ Collaboration between IC makers and Broadcasters

▶ Innovation takes time

▶ There is Hope!!!

**Oren**