TrueCircuit™ Technology

A fast, low cost, and adaptable way to distribute Video, Audio, Control, and Metadata via widespread IP networking technology

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Agenda

- Different Network criteria's
- The history of Ethernet, IP, and TCP/IP
- Advantages of IP/Ethernet
- Disadvantages and Challenges of IP/Ethernet
- Quality of Service (QoS)
- What is TrueCircuit?
- Market Trends and Applications
- Summary
There are three main criteria’s of how to select the right network technology

- Make sure the network offers the solution to your problem
- Evaluate the trade-off of the technical concept proportional to price
- Pay only as much as necessary
Today there are five important different networks available

- ATM
- IEEE 1394 (Fire Wire)
- Fiber Channel
- IP
- XY-Router
Different Networks are used for different applications

Network Comparison

- ATM
- IEEE 1394
- Fiber Channel
- IP Based
- XY-Router

<table>
<thead>
<tr>
<th>Scalability</th>
<th>QoS</th>
<th>Price</th>
<th>Security</th>
<th>Reliability</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td></td>
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</table>
TrueCircuit™ enables IP networks to be used more effective.
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Ethernet and IP are based on research funded by ARPA

- Back in the mid 70s Ethernet, IP, and TCP/IP were developed based on research funded by ARPA (Advanced Research Projects Agency)
- University researchers were encouraged to adopt these new protocols to exchange information
- ARPANET and MILNET existed at this time
- No provisions were made for Quality of Service or security
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IP/Ethernet offers several advantages

- IP/Ethernet is well known and widely used
- IP/Ethernet is the backbone of the Internet
- Billions of dollars are being invested in developing IP/Ethernet
- IP/Ethernet is the revenue generator for the future
- Multiple vendors / low cost
- IP/Ethernet is the focus for all future commerce
IP/Ethernet offers huge bandwidth at affordable cost

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bandwidth</th>
<th>Bandwidth / Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Base-T</td>
<td>10 Mb/s</td>
<td>x10 the bandwidth / x2 the price</td>
</tr>
<tr>
<td>100 Base-T</td>
<td>100 Mb/s</td>
<td>x10 the bandwidth / x2 the price</td>
</tr>
<tr>
<td>1000 Base-T</td>
<td>1 Gb/s</td>
<td>x10 the bandwidth / x2 the price</td>
</tr>
<tr>
<td>10000 Base-SX</td>
<td>10 Gb/s</td>
<td>?</td>
</tr>
</tbody>
</table>

x10 the bandwidth / x2 the price

think video ® LEITCH
IP is more cost efficient compared to ATM and other networks

- An 8 port Gigabit Ethernet switch costs between US $ 10-12k
- An 8 port OC-12 (622Mb/s) ATM switch costs between US $ 70-80k
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Ethernet is defined as “Best Effort Delivery” mechanism

- Hardware provides no information to the sender about whether packets have been delivered
- Ethernet access control is distributed and called Carrier Sense Multiple Access with Collision Detect (CSMA/CD)
- Almost no Quality of Service (QoS) is provided
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QoS determines the performance properties of connections and defines the value of the service.

*Five parameters are important for offering QoS:*

- **Bandwidth**
- **Latency**
- **Jitter**
- **Order**
- **Loss**
TrueCircuit™ offers extreme high QoS

- Fully compatible with standard IP equipment
- Provides IP QoS equivalent to ATM
- Creates Virtual Circuits
- Low Jitter
- Guarantees the right order, No Loss of packets
- Low Latency (5ms guaranteed), High Bandwidth Utilization (up to 94%)
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TrueCircuit™ combines two techniques to guarantee QoS and is patent pending

- TrueCircuit™ = IP (Internet Protocol) + TDMA (Time Division Multiplex Access)
- Data streams are assigned time-slots
- This offers tremendous benefits:
  - compliant to existing IP standards
  - fixed latency
  - no collision
  - no queuing
  - high bandwidth efficiency
- Precision synchronization of data streams
TrueCircuit™ generates T-Blocks and time stamps for each T-Block

- T-Block - 16ms = 4000 Slots
- Slot - 4us = IP Packet
- IP Packet - 512 bytes
- 512 bytes x 8 = 4kb x 4000 = 16Mb (1/16ms) = 1Gb/s
TrueCircuit™ is implemented in Layers 1-3, other QoS standards operate only on Layer 3

This offers tremendous benefits:
• compliant to existing IP standards fixed latency
• no collision
• no queuing
• high bandwidth efficiency
TrueCircuit™ offers multiple advantages compared to other network protocols

<table>
<thead>
<tr>
<th></th>
<th>True Circuit</th>
<th>IntServ /w RSVP</th>
<th>DiffServ</th>
<th>MPLS</th>
<th>ATM</th>
<th>IEEE 1394(^1)</th>
<th>Fibre Channel(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>94%</td>
<td>Over IP</td>
<td>Over IP</td>
<td>Over IP</td>
<td>83-90.6%</td>
<td>~75-80%</td>
<td>~94.6-98.3%</td>
</tr>
<tr>
<td>Latency</td>
<td>5ms</td>
<td>Switch-dependent (Rspec)</td>
<td>Switch-dependent</td>
<td>Switch-dependent (CR-LDP)</td>
<td>MaxCTD</td>
<td>5us</td>
<td>~35us</td>
</tr>
<tr>
<td>Jitter</td>
<td>10 us</td>
<td>Switch-dependent (Rspec)</td>
<td>Switch-dependent</td>
<td>Switch-dependent (CR-LDP)</td>
<td>p-pCDV</td>
<td>300us</td>
<td>TBD</td>
</tr>
<tr>
<td>Loss</td>
<td>None</td>
<td>Possibly (due to soft reservation)</td>
<td>Yes</td>
<td>Possibly (CoS bits, TTL)</td>
<td>If CLP=1</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Order</td>
<td>Guaranteed</td>
<td>Guaranteed</td>
<td>Guaranteed if IP packets in a microflow belong to same AF class.</td>
<td>Guaranteed if explicit setup</td>
<td>Guaranteed if isochronous channel</td>
<td>Guaranteed if class 1 or class 4 data</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)These values assume the use of isochronous channels.

\(^2\)These values assume the use of Fibre Channel Class 4 Fractional Guaranteed Bandwidth or Class 1
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TrueCircuit™ is designed for LAN and WAN applications
The future will be a fully integrated Broadcast Network Solution
There is the trend to migrate to a fully integrated Network solution.

traditional X-Y routing (point-to-point connection) vs. fully integrated Network solutions
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TrueCircuit™ prepares us for the future

- Provides the technology to migrate to a fully Networked LAN Broadcast Operation vs. traditional X-Y Router
- Offers full Network flexibility
- Reduces cost compared to traditional X-Y operations
- Synchronizes video via Genlock, which can be distributed via the Ethernet network
- Offers full QoS to ensure Broadcasters requirements
Think IP@Leitch