Arrive is a Carrier-Class Broadband and Packet Network Semiconductor and Software Solution Company with a broad portfolio of highly integrated Systems-on-a-Chip Products and Acceleration Software Products for the worldwide communications market.

Our CodeChips® and Acceleration Software provide flexible, next-generation solutions allowing our customers to meet their growing network connection, security, integration, and management needs.
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Key Product Lines

**Acceleration Software Product Line**

Arrive provides state-of-the-art Acceleration Software for advanced security, switching, and media management solutions for the Cloud Computing, Data Centers, and NFV markets. Arrive’s Acceleration Software provides reusable software components that can be employed across the network and offers a variety of EaaS (everything-as-a-service) components including communications, infrastructure, data, and platforms applications. The Acceleration Software resides on the FPGA in either Smart-NIC or Cloud-Based Platform equipment offering significant advances in speed and computing performance in the network.

**CodeChip™ Product Line**

CodeChips are system-on-a-chip solutions that are integrated onto advanced leading-edge FPGAs. Arrive’s flexible CodeChip architecture allows for design changes in real-time, while providing flexibility to accommodate multiple design requirements, adapt to variances in worldwide network standards, and adjust to future technical standard changes—all at a price competitive with fixed-feature ASICs. PCB size, BOM, and power consumption are also reduced by the Arrive CodeChip architecture.

The CodeChip family begins with a series of core features. From these, each specific design is built to customer specifications.

There are currently four CodeChip families:

- Pseudowire CodeChips
- SONET/SDH CodeChips
- Carrier Ethernet CodeChips
- Multi-Services OTN and CPRI over OTN CodeChips

Arrive is also currently developing a new family of Next Generation CodeChips™. This new family will provide a rich menu of FPGA-based IP to accelerate CPU performance for SDN/NFV applications.

**The CodeChip Advantage**

CodeChip is more than just IP blocks for FPGAs. An Arrive CodeChip includes the full FPGA Image, a full software development kit including APIs and Drivers, and is backed by the world-class integration and testing experience of Arrive. Many customer applications require combinations of these product lines, and Arrive has the experience to combine these solutions effectively.

**Multiservice ADM ASIC Product Line**

Arrive also specializes in high capacity ASIC devices. Arrive’s AT4848 is a highly integrated OC-48/STM-16 or OC-12/STM-4 or OC-3/STM-1 Multiservice ADM (Add/Drop Multiplexer) on a chip. Devices in this family can be used in a variety of voice and data over SONET/SDH systems including Multiservice Provisioning Platforms (MSPP), broadband access and enterprise customer premise equipment with an integrated ADM.
Bay® Acceleration Software for Security and Cryptography

Bay Acceleration Software can be used to accelerate Cloud platform (PaaS), Data Center or NFV solutions. Bay provides rich features for multiple security and cryptography protocols from Layer 3 to Layer 7 applications in a flexible FPGA architecture. Bay achieves up to 200Gbps throughput for L3 IPSec, SSL/TLS acceleration, Packet Capturing and L3-L7 Traffic Monitoring, Deep Packet Inspection and Load Balancer, and Data Compression/Decompression features.

Bay Acceleration Software Key Features

L3 IPSec

- 200Gbps IPSec throughput
- Up to 128K IPSec VPN traffic flows
- Internet Key Exchange protocol IKEv1 & IKEv2
- Authentication protocols: AES GMAC, AES XCBC, HMAC
- Encryption protocols: AES (128/192/256bits) CBC, AES (128/192/256bits) GCM, DES, 3DES, ARC4

SSL/TLS Offloading

- SSL/TLS offloading/acceleration for CPU Host
- Various Public-key Encryption protocols: RSA 4096/3072/2048/1024, SHA512/384/256/224/1, ECC (Elliptic Curve Cryptography), ECDSA (Elliptic Curve Digital Signature Algorithm), ECDH (Elliptic-curve Diffie–Hellman)
- Pre-shared key encryption: AES-256/128
- 200K CPS (connections per second) for all types of Public-Key encryption
- Up to 200Gbps bulk throughput
Packet Capturing and L3-L7 Traffic Monitoring

- Real-time 200Gbps packet capturing for all packet sizes
- Up to 128K rules for packet classification
- Up to 1 millions flows for L3-L7 Traffic Monitoring
- Highly flexible and programmable for software with state-of-the-art P4 networking programming language

Deep Packet Inspection/Load Balancer

- Up to 200Gbps L3-L7 Deep Packet Inspection (DPI)
- Load Balancer capability based on DPI engine
- Packet timestamping and latency measurement in hardware with nanosecond accuracy
- Highly flexible and programmable for software with state-of-the-art P4 networking programming language

Data Compression/Decompression

- Up to 100G data compression/decompression with DEFLATE/LZS
Eva® Acceleration Software for Networking

Eva Acceleration Software is a Switching/Routing acceleration solution for NFV applications using FPGA architecture. Eva is best suited in a Smart-NIC form, and can be used to offload the CPU workload and increase performance for multiple functions, including L2 Switching, L3 Routing, QoS, overlay network protocols (VXLAN, NGVRE) and many others. Eva can support up to 200Gbps throughput and support millions of flows. Using the P4 programming language, Eva can be used in many flexible ways, enabling customers to build user-defined networks. Eva Acceleration Software can be combined with Arrive’s Bay Acceleration Software to add security and cryptography features to provide full networking solutions.

Eva Acceleration Software Key Features

Throughput

- 200Gbps throughput with 2x100GE interfaces
- 200 million packets per second (Mpps) processing capability for all protocols, all layers at the same time
Packet Processor

- 200Gbps/200Mpps P4 programming language engine
- Up to 1 million programmable tunnels/flows support flexible L2-L7 protocols and easily adapt to new protocols with software-define based including:
  - L2 MAC/VLAN switching
  - Overlay protocols: VXLAN/NVGRE
  - L3 IPv4/IPv6 routing
  - TCP/UDP offloading
  - Network Address Translation (NAT)
  - Access Control List (ACL)

Additional Security Features

- 200G MACSec, IPSec
- SSL/TLS offloading
- Public-key cryptography acceleration
- L3-L7 Deep packet inspection, Traffic Monitoring

Traffic Manager/QoS

- 200Gbps Hierarchical Traffic Manager (H-QoS) with 8K queues and 3-stages
- MEF 10.2/10.3 bandwidth profile compliant
- DSCP classification/remarking
- Weighted Random Early Detection (WRED)
- Scheduling: SP, DWRR, SP+DWRR
- Multiple queues per Virtual Machine (VM)

Timing

- Hardware timestamping for 1588v2/PTP packets with sub-nanosecond accuracy
- Support BC/OC/TC PTP packets in L2/L3/MPLS formats
Elsa® Acceleration Software for Media Encoding, Transcoding and Encryption

Elsa Acceleration Software provides the acceleration for Media Encoding, Transcoding and Encryption in a flexible FPGA architecture. It can be used to offload video streaming and media processing services for cloud-based platform (PaaS) or Data Center servers with significantly faster results and lower power consumption. Elsa provides very low latency media encryption features over multiple streams simultaneously. Elsa also supports wide range of encoding and transcoding standards, as well as high-speed encryption for Media and Video applications.

Elsa Acceleration Software Key Features

Video Encoding

- Support FPGA-based full video encoding
- Sub-millisecond latency, reduce lag-time for live video streaming and real-time applications
- Support wide range encoding standards: H.265/HEVC, VP9 and upcoming VP10/AV1, NETVC codec standards
- Support simultaneously 32 streams

Video Transcoding

- Fully support Adaptive Bit Rate (ABR) streaming with wide range streaming standards:
  - Apple HTTP Live Streaming (HLS)
  - MPEG-DASH
  - Microsoft Smooth Streaming

Video Encryption

- FPGA-based acceleration for Video Encryption (AES-128/AES-256) for DRM (Digital Right Management) with 10x faster than CPU/GPU
Multi-Services OTN CodeChips

Arrive’s Multi-Services OTN CodeChip offers up to a 100Gbps OTN processor, with highly integrated capabilities for SONET/SDH, CES/CEP, and Carrier Ethernet features. The network side can support multiple OTU rates (OTU4/OTU2/OTU2r/OTU2f/OTU2e/OTU1f/OTU1) and up to 32 transceivers on the client side can be configured with various protocols: SONET/SDH, 1GE/10GE/40GE/100GE, Fiber Channel, ESCON/FICON, Infiniband, SDI/DVB-ASI, CPRI, CBR or XAUI/Interlaken for OTN-over-Fabric.

The Multi-Services OTN CodeChip can be used in a pizza-box or system linecard for OTN Transponder/Muxponder/ODUk Switching or P-OTS with additional customer-defined functions. A variation of the OTN CodeChip can be used for CPRI-over-OTN in a small size FPGA. This CodeChip provides high quality frequency and very low latency that can provide a cost effective solution for next generation C-RAN Mobile Fronthaul while still meeting the strict timing requirements of CPRI and 3GPP.
OTN CodeChip Key Features

OTN Features

- Up to 100Gbps with 1xOTU4 or 4xOTU2/2r/2e/2f/1e/1f at Network Side
- Up to 32 client ports with up to 100G (11.7G for lo-order muxponder), multiple protocols support:
  - OTU0-OTU1/1e/1f-OTU2/2r/2e/2f
  - SONET/SDH: STM-256/64/16/4/1 – OC768/192/48/12/3
  - 100G/40G/10G/1G/100M Ethernet
  - GPON/XGPON
  - CPRI option 1-8
  - CBR 1G/2.5G/10G/40G
  - FibreChannel (100/200/400/800/1200/1600/3200 FC)
  - Infiniband (SDR/DDR/QDR IB)
  - ESCON
  - SDI/DVB_ASI
- ITU-T G.709 compliant
- AES-256 Data Encryption/Decryption for OTN traffic or MACSec, IPSec
- Support CPRI over OTN with multiple mapping: G.Sup56, GFP-T
- 230Gbps ODUk SAR (OIF-OFP-01.0) with Interlaken
- 230Gbps ODUk Switch

Integrated Features

- Integrated SONET/SDH MSPP with VCAT/LCAS, GFP/HDLC/MLPPP/Multi-Frame Relay
- Integrated high capacity, deep channelized for lo-order SONET/SDH and PDH processing
- Integrated High-order/Low-order CES/CEP
- Integrated L2/MPLS Switch with OAM/1588v2/SyncE

Target Applications

- Reconfigurable Add-Drop Multiplexers (ROADMs)
- OTN Transponder/Muxponder/ Switching/P-OTS
- Multiservice line-card for OTN Metro Access Network
- CRAN – OTN Mobile Fronthaul
OTN Fronthaul Solution

OTN Fronthaul Features

- 100Gbps+ throughput
- OTU4 Line interface
- CPRI interface
  - CPRI option 1 to 10
  - eCPRI
- Support CPRI over OTN for 3G/4G network
- Support IEEE 1904 Radio-over-Ethernet Mapper
- Support eCPRI transport over OTN
- Flexible features for OAM, protection and timing synchronization
- Low latency
Carrier Ethernet CodeChips

Arrive’s Carrier Ethernet CodeChip devices offer Packet Processing, Switching, Routing targeted with different capacities, I/O, features and cost to meet the varied needs of equipment suppliers. The Carrier Ethernet CodeChips can be used on various packet system line cards and pizza-box systems for optical packet transport and packet radio transport. Broad applications include wireline networks and wireless networks. Many specific applications are possible, such as IP/MPLS, WDM-PON, FTTH, wholesale Ethernet, LTE, 3G and 4G backhaul, microwave radio backhaul, eNodeB and RT.

Carrier Ethernet CodeChips, Bandwidth Specific Features

<table>
<thead>
<tr>
<th>CodeChip</th>
<th>8-24G</th>
<th>24-40G</th>
<th>80G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switching Capacity</td>
<td>Up to 24Gbps</td>
<td>Up to 40 Gbps</td>
<td>Up to 80Gbps</td>
</tr>
<tr>
<td>10 GbE Ports</td>
<td>1 or 2, XAUI or 10GBASE-R/KR</td>
<td>1 or 4, XAUI or 10GBASE-R/KR</td>
<td>1 or 8, XAUI or 10GBASE-R/KR</td>
</tr>
<tr>
<td>GbE Ports</td>
<td>Up to 24</td>
<td>Up to 32</td>
<td>Up to 32</td>
</tr>
</tbody>
</table>

Carrier Ethernet CodeChips, Key Features

- L2/MPLS/MPLS-TP Switching and L3 IPv4/IPv6 Routing
- Support Hierarchical QoS (H-QoS) for flexible per flow/per service Traffic Manager or simple QoS (8 queues/port) for smaller size FPGA.
- Optional MACSec/IPSec security
- TWAMP hardware acceleration
- OAM Modes:
  - IEEE 802.1ag/ ITU-T Y.1731 CFM (Connectivity Fault Management) OAM with hardware acceleration engine
  - CFM/BFD OAM with hardware acceleration for MPLS-TP
  - IEEE 802.3ah EFM (Ethernet in the First Mile) OAM
- Sub-50ms protection switching times
- Protection Modes:
  - Ethernet Linear Protection Switching 1+1, 1:1 (G.8031)
  - Ethernet Ring Protection Switching (G.8032)
  - MPLS Linear/Shared Ring protection
  - Ethernet link aggregation (IEEE 802.3ad)
  - Spanning tree (STP), Rapid spanning tree (RSTP)
- IEEE 1588v2
- G.8262/Y.1362 Synchronous Ethernet (SyncE)
- Optional support via a companion FPGA:
  - CES, CEP
  - ATM/IMA
  - PPP/MLPPP
  - EoS, EoPDH
Pseudowire CodeChips

Arrive’s Pseudowire CodeChip product line offers a family of complete pseudowire and mobile backhaul CodeChip devices. Arrive provides total solutions in groupings of 1 to 32 E1/DS1/J1 lines; aggregation nodes with up to 84/63 DS1/E1 lines; high-density nodes with 336/252 DS1/E1 or OC-12/STM-4 lines; or very dense nodes with 5376/4032 DS1/E1/J1 or 1xOC192/STM-64 - 4xOC48/STM16 lines. The aggregation and higher density nodes use SONET/SDH interfaces for service side connection. The Pseudowire CodeChip family is described in more detail on the Arrive website.

Pseudowire CodeChip Applications

- Metropolitan Area Network Aggregation
- PON, Cable and Wimax backhaul systems
- Gateway of Pseudowire and voice trunking
- Aggregation of Packet Mobile Backhaul
- Metro Ethernet Equipment
- TDM and LAN aggregation

High Channel Count Pseudowire CodeChip Block Diagram
Pseudowire CodeChips - Key Features

- SAToP/CESoPSN/TDMoIP/MEF8 Circuit Emulation Services for E1/T1/E3/T3
- Circuit Emulation over Packet (CEP) for OC3/12/48
- Timing modes for DS1/E1 include: ACR/DCR, EPAR/APM, external reference, looptime
- ACR/DCR clock recovery algorithm for SAToP and CESoPSN, per ITU G.8261, G.823, G.824 and MEF22
- Very low-cost DDR2/3 for large buffers
- Application-specific high-level API software development kit

E1/T1/E3/T3 Pseudowire CodeChips

- Supports up to 63 E1/T1 or 24 E3/T3 pseudowires over packet switched network (SAToP/CESoPSN), ATM pseudowire and packet pseudowire as per RFC4553 and RFC5086
- Intergrated PDH Framers with M13
- 1+1 GbE Interface for network side

STM-1/OC-3, STM-4/OC-12, and STM-16/OC-48 Pseudowire CodeChips

- Supports up to 1xOC192/STM-64 - 4xOC48/STM16 or 5376/4032 DS1/E1/J1
- PDH pseudowire (CES: SAToP and CESoPSN) as per RFC4553, RFC5086, etc.
- SONET/SDH pseudowire (CEP) as per RFC4842
- DS1, E1, J1, DS3, E3, with optional M13/E13
- CEP modes include: VC11, VC12, VC-3 (Basic and Fractional), VC-4 (Basic and Fractional)
- High channel count pseudowire connections with NxDS0 capability
- OC12/STM-4 or OC-3/STM-1 interfaces at service side
- DS1, E1, J1, DS3, E3, with optional M13/E13
- GbE interfaces: One active and one standby
- APM and EPAR Timing modes for CEP
SONET/SDH CodeChips

Arrive’s SONET/SDH CodeChip product line offers a family of highly integrated SONET/SDH Framer/Mapper products that can be used in Linear or Ring topology SONET/SDH networks. They can support typical transport configurations, including PDH-over-SONET/SDH, Ethernet-over-PDH, Ethernet-over-PDH over-SONET/SDH, Ethernet-over-SONET/SDH, SONET/SDH ADM, SONET/SDH MSPP.

The SONET/SDH CodeChip family begins with a series of core features based on the proven AT4848 ASIC and other devices. From these, each specific design is tailored to a customer’s specifications. Following are several example configurations; the family of devices is described in more detail on the Arrive website.

SONET/SDH CodeChip Key Features

<table>
<thead>
<tr>
<th>Core</th>
<th>Bandwidth</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>SONET/SDH and/or PDH ADM</td>
<td>16Mbps (8xE1/T1) to 20Gbps</td>
<td>• Linear ADM , 1+1 MSP , UPSR/SNCP</td>
</tr>
<tr>
<td></td>
<td>(2xOC192 or 8xOC48)</td>
<td>• Cross-connect</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Full PDH (E3/T3/E1/T1) framer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ethernet over SONET with LCAS/VCAT</td>
</tr>
<tr>
<td>SONET/SDH EoS/EoPDH/POS</td>
<td>155Mbps (OC3) to 20Gbps (2xOC192</td>
<td>• Channelized Ethernet over TDM (EoS, EoPDH)</td>
</tr>
<tr>
<td></td>
<td>or 8xOC48)</td>
<td>• VCAT-LCAS, GFP/HDLC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Packet over SONET/SDH (POS)</td>
</tr>
<tr>
<td>SONET/SDH MSPP</td>
<td>155Mbps (OC3) to 10Gbps (1xOC192</td>
<td>• Full SONET/SDH features</td>
</tr>
<tr>
<td></td>
<td>or 4xOC48)</td>
<td>• Full PDH features</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PPP/MLPPP/Frame Relay/ Multi-Frame Relay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ATM/IMA</td>
</tr>
</tbody>
</table>

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CodeChip SDK (Software Development Kit)

All Arrive CodeChips come with a Software Development Kit. Major features are:

- Platform independent via a Hardware Abstraction Layer (HAL) module
- Operating System independent via Operating System Abstraction Layer (OSAL) module
- Modular device driver allowing transparent interface to higher level application layer
- Relieves the system software developer of the task of recreating the CodeChip device driver to speed up the system development and ensure a quick transition to production
- Compliant to standard telecommunications functions including configuration
- Supports interrupt handler
- Includes a command line debugger for controlling and monitoring the device
- Compliant to ANSI-C

Evaluation Platforms

Arrive has developed evaluation platforms for the CodeChip and Multiservice ADM ASIC products. These platforms are designed to allow prospective customers to comprehensively test and evaluate Arrive's solutions and for existing customers to develop applications software prior to their own hardware becoming available.

EP5/EP6s are standalone boards that allow operation and interoperability testing of the different CodeChip families through various interfaces. User manuals provide an overview of the capabilities and features of the EP5/EP6 boards. Evaluation and testing can be controlled via a 10/100BT Ethernet port which is connected to the onboard CPU by either a PC or a LAN. A standard RS-232 debugging port is also provided.

For more information on Arrive's Acceleration, Codechip and ASIC solutions, please visit our website at

www.arrivetechnologies.com

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