

IPX: Call Direction Understanding Primary vs. Secondary

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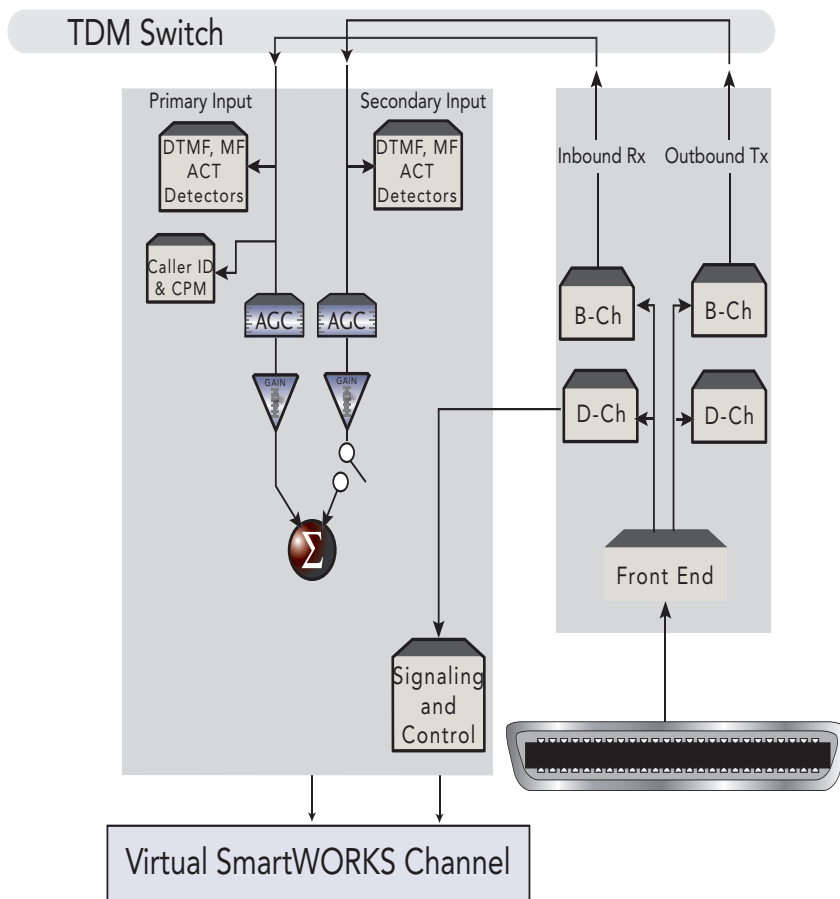
On a conventional circuit-based network, once a call is established, the physical path between the two end points is fixed. In the IP world, the two end points are not fixed and are viewed as connectionless. Packets carrying signaling or voice data for a single call can be routed through different paths.

To compensate for this, new logic was developed within the SmartWORKS DLL to adapt to this environment. This document outlines how the SmartWORKS DLL responds to a VoIP network and provides the application developer with a deeper understanding of how use the SmartWORKS IPX to monitor call state, media sessions and call direction when tapping VoIP networks.

Call Monitoring on Legacy Networks

Legacy SmartWORKS boards are designed for traditional PSTN systems where a channel is a physical element or a fixed timeslot on each network. During initialization, as the Physical Boards are numbered, the SmartWORKS software builds a list of the logical channels available in the system. Each logical channel corresponds to a full duplex path between a single phone and the PBX. Using the SmartWORKS NGX as an example, the tap is positioned between the PBX and phones. Each SmartWORKS logical channel can be physically mapped to a single phone's receive (Rx) and transmit (Tx) paths. B-channel data *received* by the phone is processed through the SmartWORKS Primary input while audio *transmitted* by the phone is processed by the Secondary input. D-channel data is processed by the board's front end. Since the physical connectors on the board can be mapped to a single SmartWORKS logical channel the board's DLL determines which data element corresponds to which channel. As a result, all B-channel and D-channel events for a single phone are reported with the same Channel ID. This same logic applies when tapping a network using the SmartWORKS DP board. In this tapping scenario, the tap is physically located between the local PBX and the Central Office (CO). The SmartWORKS DLL relies on timeslot information to associate a channel ID with both B-channel and D-channel events.

The following diagram illustrates this concept:



Once the application developer understands the SmartWORKS logical channel, then one can determine the direction of the audio path using the endpoint, phone, as a reference point. The user can easily understand the direction of the audio path relative to the audio the phone is *receiving* versus the audio that the phone is *transmitting*. The audio path is always fixed relative to the tapped phone.

Determining call direction, or whether the call is incoming vs. outgoing, relies on the application developer to monitor D-channel events or call control events. When call control events are reported (ISDN PRI with the DP board, or ISDN BRI with the NGX board) the MT_CC_CALL_INFO data structure contains a call source field that indicates whether this call is incoming or outgoing. When tapping with the NGX on non-ISDN environments, the application must rely on D-channel events such as EVT_RING_ON which indicates an incoming call or EVT_DIGIT_PRESSED which may indicate that the monitored call agent is placing an outbound call.

Call Monitoring on VoIP Networks

VoIP networks are inherently connectionless, meaning there is no single wire connection between the local endpoint (phone) and call control server (PBX or gateway). To compensate for this, new logic was developed within the SmartWORKS DLL to adapt to this environment. When the IPX is tapped into the line, the SmartWORKS DLL does not open logical channels as there is no physical mapping between the IPX's connector and the tapped phones. In this scenario, the IPX monitors the tapped line for signaling packets, identifies each VoIP endpoint and assigns each with a Station ID. The IPX maintains a list of each VoIP station and its associated IP Address and port number. All events reported by the IPX are reported with this Station ID. The IPX does not have any DSP's, therefore the audio path is not processed by the IPX.

Monitoring Media (Voice Connections)

Relying on signaling information, the IPX monitors the network for media connections which is used to establish an audio path. This audio path may represent a connection to a network device that delivers call progress tones (such as dial tones) or a voice path between the two VoIP endpoints associated with this call. When a media connection is fully established, the IPX reports a single media session started event that represents the full duplex connection (two RTP streams). Each media session event is reported with a Station ID, as well as Session ID. This Session ID is used by the application to monitor this session, plus control forwarding options. This event (EVT_MEDIA_SESSION_STARTED) provides the user application with the following information:

NOTE: The information presented with a media session event, is with respect to the station that reported the event.

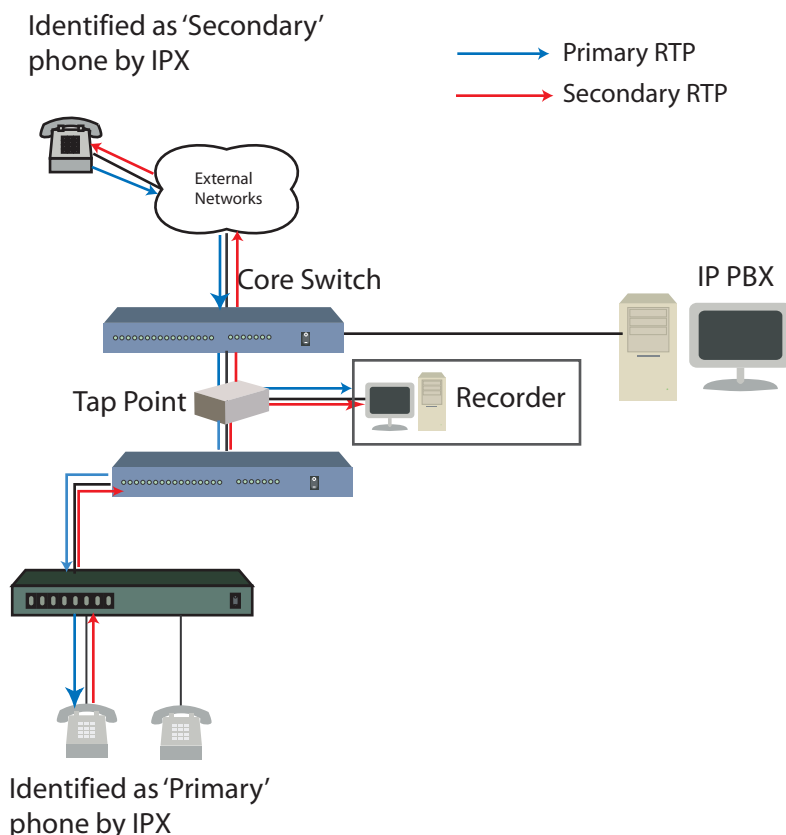
SessionID:	The Session ID associated with this RTP media connection
PrimaryUDPPort:	The UDP port used by the phone(on the tapped network) to <i>receive</i> RTP packets with respect to the station that reported the event
SecondaryUDPPort:	The UDP port used by the VoIP endpoint (not on the tapped network) to <i>receive</i> RTP packets
PrimaryIPAddress:	The IP address of the phone on the tapped network
SecondaryIPAddress:	The IP address of the VoIP endpoint that is not on the tapped network
Codec:	Codec of the RTP packets. This field is used for backwards compatibility
PrimaryCodec:	Codec used by the primary station when transmitting RTP

SecondaryCodec:	Codec used by the secondary station when transmitting RTP
CallRef:	A unique call reference number. This value is protocol dependant, refer to the IPX Integration Guide for details

Interpreting the Primary and Secondary

Each media session event reports information about the two VoIP endpoints associated with this connection. In most scenarios, only a single endpoint of the full duplex conversation is visible to the IPX. In this scenario, the IPX designates this endpoint as the 'Primary' endpoint, while the 'Secondary' information relates to the phone on the far side. These designations are merely used as reference points. The Primary/Secondary designation cannot be used to determine call direction (incoming/outgoing). *The user application must rely on D-channel or Call Control events to determine call direction.* The RTP packets associated with the 'Primary' endpoint refer to the packets that the local phone is *receiving* while the Secondary packets refer to the packets that this local phone is *transmitting* (received by the far side).

The following diagram illustrates this concept:



Peer-to-Peer Calling

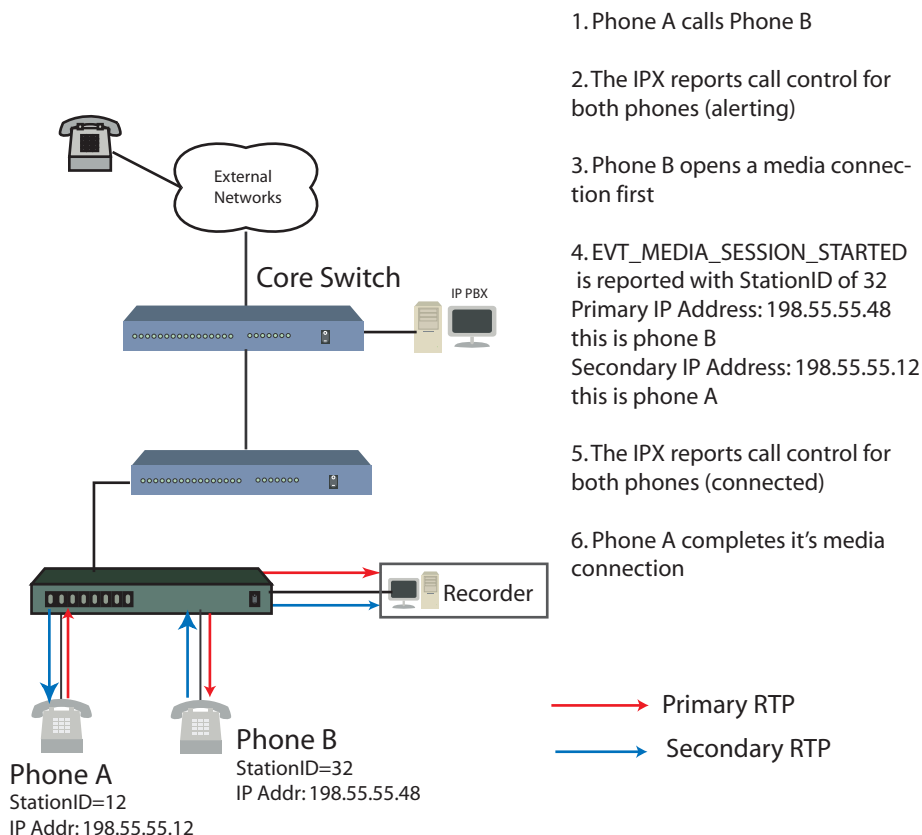
At times, two internal phones may place a call to one another. This is commonly referred to as peer-to-peer calling. In the event that both phones are tapped by a single IPX, the IPX filters out one phone and only reports a single media session with a single Station ID. (**NOTE:** Call control events are reported for both phones). In this scenario, it is easy to assume that the phone which initiated the call is also used by the IPX to report the media session and is thus the 'Primary' phone. *This is incorrect.*

The reality:

The IPX is monitoring the signaling information of both phones. When a media connection has been fully established on one of the phones, the IPX reports EVT_MEDIA_SESSION_STARTED for this phone - reporting this phone's StationID. The 'Primary' phone is the phone with the StationID used when EVT_MEDIA_SESSION_STARTED was reported. The two IP Addresses and port numbers associated with this media connection are also reported. As the second phone establishes its media connection, the IPX receives this signaling information. However, the IPX does a comparison and can ascertain that a media session event has already been reported based on the two IP Addresses and port numbers. This media connection is not reported by the IPX.

When monitoring a peer-to-peer call, the media session event can be reported for either phone. The determining factor is which phone, as observed by the IPX, establishes a media connection first.

The following illustration explains this concept:



Determining Call Direction

It is now understood that media session events do *not* relate to the call direction (incoming or outgoing). To determine the direction of the call the user application must rely on D-channel or Call Control events. Most IPX integrations support call control event reporting. When a call control event (EVT_CC_CALL_xxxx) is reported a data structure is passed over to the user application. This structure contains a *CallSource* field which indicates the direction of the call - incoming or outgoing. This same data structure is populated when passively tapping ISDN line with the SmartWORKS DP board.

Should the IPX be used in an environment where call control event reporting is not supported, the user application must rely on D-channel events much like applications designed with the SmartWORKS NGX card. For example, when using the NGX EVT_RING_ON can be used to indicate that an incoming call is present on the line. EVT_DIGIT_PRESSED may indicate that the call agent is dialing a number for an outbound call.