SCION border router with P4

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Outline

- Some SCION principles...
- SCION at SIDN Labs...
- Challenges in hardware...



Some SCION principles



SCION

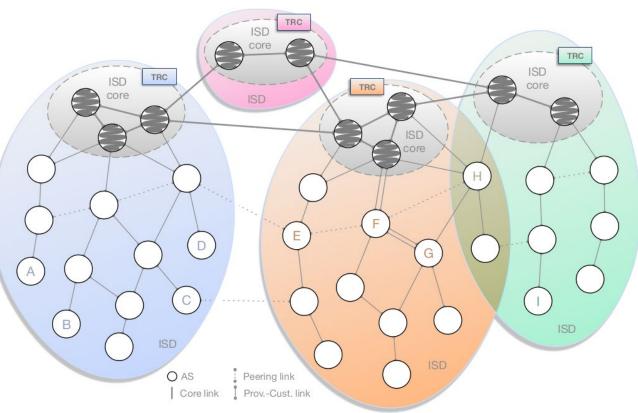


- Scalability, Control, and Isolation On Next-generation Networks
- New inter-networking architecture
- Routes authenticated both in control and data plane
 - Path control by sender: transparency
 - Multiple paths: stable
- Scalability and security through Isolation Domains (ISDs)
 - Isolation of compromise: security
 - For instance per country or jurisdiction: transparency
- Research at ETH Zürich



Isolation Domains

- PKI organised per Isolation Domain (ISD)
- core ASes managing the ISD core
 - For instance per country or jurisdiction
- Hierarchical control plane
 - Inter-ISD control plane
 - Intra-ISD control plane



Source: The SCION Internet Architecture: An Internet Architecture for the 21st Century, Barrera et al., 2017



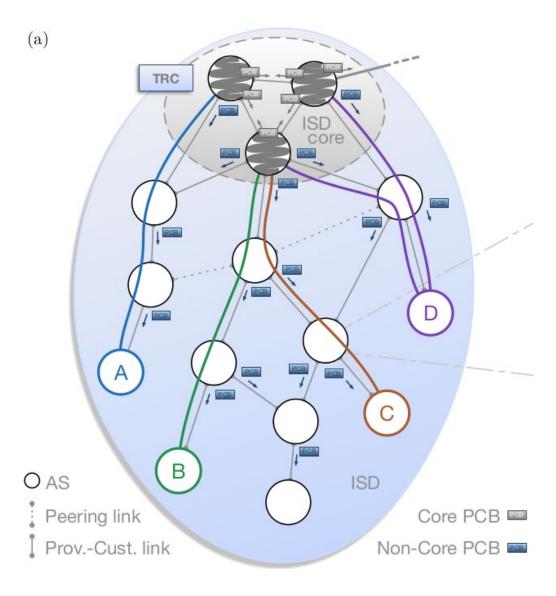
Path discovery

- Inter-ISD
 - Performed by core ASes
 - Flooding similar as with BGP
 - Less ASes involved (only core ASes)
- Intra-ISD...
 - Downstream multi-path flooding



Intra-ISD path discovery

- Path Construction Beacons (PCBs) sent downstream using multi-path flooding
 - Initiated by ISD core nodes
 - Extended and forwarded by receiving ASes
 - Add IN and OUT interface and optional peerings
- Eventually all nodes know how ISD core can be reached
- AS registers preferred down-segments (path from ISD core to AS) with Path Server in the ISD core
- Preferred up-segments registered with Local Path Server





Isolation of compromise

- Path Construction Beacons are signed by every AS along the path:
 - Can be verified within ISD
- Contain Hop-Fields (HF) for use in later select paths
 - Contain Message Authentication Code (MAC) computed using Hop-Field key
 - Only processed locally by AS
- Provides security (DDoS, route hijacking)



Path control by sender

- Path construction performed by sender
- Request route to (ISD, AS) from Local Path Server
- Local Path Server replies with lists of
 - up-path segments to local ISD core
 - core-path segments to connect up-path and down-path segments
 - down-path segment in remote ISD from ISD core to destination AS
- Sender combines segments to determine path
- Provides transparency

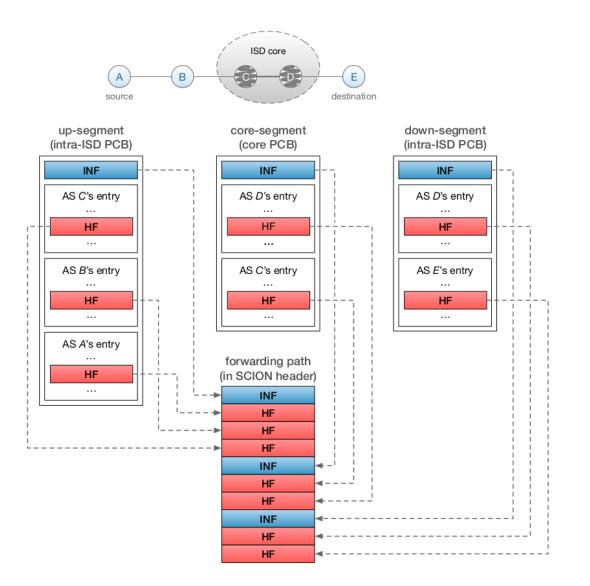


Routing

Path information included in SCION packet header Corresponding Hop-Field included Contain Message Authentication Code (MAC) computed using Hop-Field key Only processed locally No forwarding tables necessary at routers Packet-carried forwarding state (PCFS) Sender selects the path Possible to use multiple paths Recipient address no longer used to route between ASs Only used by the destination AS



Routing





Source: SCION: A Secure Internet Architecture, Perrig et al., 2017

SCION packet header

0								8							1 6							2 4					
V	ersio	n		D	stT	ype	е	-		S	rcT	ype	Э		Т	otal	Le	n						-			
Н	eade	erL	er	1				С	urr	INF					С	urrl	HF					N	ext	Hd	r		
D	stISI	D						_				D	stA	S													
S	rcISI	D										S	rcA	S													
D	stHo	st	Ad	dr	(2,	4,	16	by	tes)																	
S	rcHo	st	Ad	dr	(2,	4,	16	by	tes)					P	ado	ding	g (0	opti	iona	al)						
In	fo fie	eld	3) k	3 b	yte	s)																					
Н	op fi	elo	d (8 b	yte	s)																					
H	op fi	elo	d (8 b	yte	s)																					
In	fo fie	eld	3) k	3 b	yte	s)																					
Н	op fi	elo	d (8 b	yte	s)																					
H	op fi	elo	d (8 b	yte	s)																					
In	fo fie	elc	3) k	3 b	yte	s)																					



SCION at SIDN Labs



SCION at SIDN Labs

- Connected to international testbed SCIONLab
- Developed SCION application: Snetcat
- Visualisation of SCION paths
- Implementation of SCION in P4
 - Implementation working in P4 simulation (simple_switch)
 - Implementation for hardware work in progress...
 - Both at ETH Zürich and SIDN Labs



Challenges in hardware



Challenges in hardware

- Implicit lengths of addresses
- Absolute reference
- Implicit number of Info-Fields
- Selection of Info-Fields and Hop-Fields
- Number of Hop-Fields variable



SCION headers – Implicit length of addreses

0		8					1					2 4					
Version	DstType	· · · -	SrcT	уре		•	Tota	Len							_		
HeaderLei		Currl	١F	7		(Curr	HF				Nex	хtН	ldr			
DstISD				Dst/	١S												
SrcISD			7	Src/	٩S												
DstHostAd	ldr (2, 4, 16	bytes)															
SrcHostAc	ldr (2, 4, 16	bytes)					Pado	ding	(opti	ona	al)						
Ir	• • • •																
Н	Implic	cit ler	ngtl	h of													
·· hos	t addres	ses	and	d pa	ado	ding	g										
H																	
Info field (8 bytes)																
Hop field ((8 bytes)																
Hop field ((8 bytes)																
Info field (8 bytes)																



SCION headers – Absolute reference

0								8								1 6								2 4						
V	ersi	on		D	stT	ype	9			S	rcT	ур	e	-	-	Т	ota	Le	n								-		 	
Н	ead	erL	.en					С	urrl	INF	-	5				С	urr	HF	•					N	ext	Hd	r			
D	stIS	D)st/	١S					Τ											
S	rcIS	D										S	Src/	15																
D	stHo	ost/	Ad	dr	(2,	4,	16	by	tes))																				
S	rcHo	ost/	Ad	dr	(2,	4,	16	by	tes))						Ρ	add	ling	g ((opti	ona	al)						_		
In	nfo fi	eld	8) 1	8 by	/tes	s)															_									
Н	op f	ielo	3) k	B b	yte	s)									Ak				-							-				
														fir	st	b	yte	e	ot	S	ele	ЭC	te	d	tie	elo	k			
Н	op f	ielo	3) k	B b	yte	s)																								
In	nfo fi	eld	8) 1	8 by	/tes	s)																								
Н	op f	ielo	3) k	B b	yte	s)																								
Н	op f	ielo	3) k	Bb	yte	s)																								
In	nfo fi	eld	8) 1	8 by	/tes	s)																								



SCION headers – Implicit number of Info-Fields

0							8							1 6								2 4						
Ve	ersio	n	D	stT	yp	e			S	rcT	ype	e		Т	ota	Lei	n	-	-									 1
He	eade	erLer	n				С	urr	INF					С	urr	HF						N	ext	Hd	r			1
Ds	stISI	D					-				D	stA	S															1
Sr	cISI	D									S	rcA	S															1
Ds	stHo	stAc	ldr	(2,	4,	16	by	tes)																			1
Sr	сНо	stAc	ldr	(2,	4,	16	by	tes)					P	ado	ding	g (0	opt	ion	al)								1
In	fo fie	eld (8 by	yte	s)																							1
Но	op fi	eld (8 b	yte	es)													m	n	ic	it ı	nu	ım	h	≏r	0	f	
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Но	op fi	eld ((8 b	yte	es)																10-	-		IU,	3			
In	fo fie	eld (8 by	yte	s) ·	4																						
Но	op fi	eld ((8 b	yte	es)																							
Но	op fi	eld (8 b	yte	es)																							
In	fo fie	eld (8 by	yte	s) '	Ľ																						



SCION headers – Selection of Info-Field and HF

0							8								1 6								2 4						
Ve	rsior	ı	D	stT	ÿp	e		-	S	rcT	ype	9		-	Т	ota	Le	n	-				-	-	-		-		
He	ader	Ler	ו				С	urr	INF						С	urr	HF						N	lext	Hd	r			
Ds	tISD										D	stA	S																
Sr	cISD										S	rcA	S																
Ds	tHos	tAd	ldr	(2,	4,	16	by	tes)																				
Sr	cHos	tAd	ldr	(2,	4,	16	by	tes)						P	ado	ding	g (opt	iona	al)								
Inf	o fie	ld (8	B b	yte	s) _[~																							
Но	p fie	ld (8 b	yte	s)					-								S	Se	leo	cte	ed	l	nfo)-	Fi	elo	d	
															7				6	an	d	H	op)-F	-ie	elc	k		
Ho	p fie	ld (8 b	yte	s)																V	ar	ia	b	е				
Inf	o fie	ld (8	8 by	yte	s) [4																							
Но	p fie	ld (8 b	yte	s)																								
Но	p fie	ld (8 b	yte	s)																								
Inf	o fie	ld (8	8 by	yte	s)	Ľ																							



SCION headers – Number of HFs variable

0		8				1 6					2 4				
Version	DstType		SrcT	уре		Tota	lLen							_	
HeaderLer	ו	Cur	rINF			Curr	ΉF				Next	Hdr	•		
DstISD				Dst/	\S										
SrcISD				Src/	٩S										
DstHostAd	ldr (2, 4, 16	6 byte	s)												
SrcHostAd	ldr (2, 4, 16	6 byte	s)			Pad	ding (option	al)						
Info field (8	8 bytes)														
Hop field (8 bytes)					Νι	ımb	er c	of H	lop	o-F	iel	lds	;	
		<u> </u>			7			va	ria	ble	;				
Hop field (8 bytes)			/											
Info field (8	8 bytes)														
Hop field (8 bytes)														
	k														
Hop field (8 bytes)														
Info field (8	8 bytes)														
	K														



Questions?

• Do people know about guidelines how to defined protocols with hardware in mind?



Volg ons

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