2STiC: Future internet technologies

Victor Reijs

SDN workshop| Zurich | 5 July 2019



## 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	e			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													
DstHostAddr (2, 4, 16 bytes)																											
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			ersion DstType Sro													1 6								2 4					
V	ersi	on		D	stT	ype	e			S	rcT	yp	e	-	-	Т	ota	Le	n										
Н	ead	erl	_en	1				Сι	urrl	NF		5				С	urr	HF						N	ext	Hd	r		
D	stIS	D									•		)st/	١S					Τ										
S	rcIS	D										S	Src/	S															
D	stHo	ost	Ad	dr	(2,	4,	16	byt	es)																				
S	rcHo	ost	Ad	dr	(2,	4,	16	byt	es)							Р	add	ling	g ((	opti	ona	al)						_	
Ir	fo f	ielo	3) k	3 by	ytes	s)											_				_								
Н	op f	fiel	d (	8 b	yte	s)								-	At	)S	ol	ut	е	re	te	re	n	ce	to	<b>)</b>			
														fir	st	b	yte	e	of	S	ele	ЭC	te	d	ti€	elo	k		
Н	op f	fiel	d (	8 b	yte	s)																							
Ir	ıfo f	ielo	3) k	3 b	ytes	s)																							
Н	op f	fiel	d (	8 b	yte	s)																							
Н	Hop field (8 bytes)																												
Ir	Info field (8 bytes)																												



## SCION headers – Implicit number of Info-Fields

0			8						1 6						2 4						
Version	DstType	;		Sr	сТу	pe	-		Tota	lLe	n	-									
HeaderLer	้า		Curr	INF					Cur	rHF					Ne	ext	Hdı	r			
DstISD						Dst/	٩S														
SrcISD						Src/	١S														
DstHostAd	ldr (2, 4,	16 I	oytes	)																	
SrcHostAd	ldr (2, 4,	16 I	bytes	)					Pac	ding	g (op	tion	al)								
Info field (	8 bytes)																				
Hop field (	8 bytes)										In	nnl	ici	it r	וור	m	h	≏r	0.	F	
									>			ιγι	Inf	fo-	.F	i D	Ы		U		
														0-			iu.	3			
Hop field (	8 bytes)																				
Hop field ( Info field (	8 bytes) 8 bytes) 4	4						·	_												
Hop field ( Info field ( Hop field (	8 bytes) 8 bytes) 8 bytes)	4							_												
Hop field ( Info field ( Hop field ( 	8 bytes) 8 bytes) 8 bytes)	K																			
Hop field ( Info field ( Hop field (  Hop field (	8 bytes) 8 bytes) 8 bytes) 8 bytes)	<																			
Hop field ( Info field ( Hop field (  Hop field ( Info field (	8 bytes) 8 bytes) 8 bytes) 8 bytes) 8 bytes)	۲																			



### SCION headers – Selection of Info-Field and HF

0					8								1 6								2 4						
Version	1	Dst	Тур	e			s	rcT	ype	e	-	-	Тс	otal	Le	n											
Header	Ler	ו			С	urr	INF						С	urrl	HF						Ν	ext	Hdı	r			
DstISD	DstISD									stA	S																
SrcISD	SrcISD									rcA	S																
DstHos	tAd	ldr (2	, 4,	16	by	tes	)																				
SrcHos	tAd	ldr (2	, 4,	16	by	tes	)						P	ado	ding	g (o	pti	ona	al)								
Info fiel	d (8	8 byte	es)	4																							
Hop fie	ld (	8 byt	es)					-								S	e	e	cte	ed	lr	nfo	<b>)-</b>	Fi	elo	b	
													7				З	n	d	H	эр	)-F	-ie	elc	1		
Hop fie	ld (	8 byt	es)																V	ar	ia	b	е				
Info fiel	d (8	8 byte	es)	K																							
Hop fie	ld (	8 byt	es)																								
Hop fie	ld (	8 byt	es)																								
Info fiel	d (8	8 byte	es)	K																							



#### SCION headers – Number of HFs variable

0		8						1 6							2 4						
Version	DstType			SrcT	уре	9		То	tall	en											
HeaderLe	n	С	urrlN	F				Сι	ırr⊦	łF					N	ext	Hdı	r			
DstISD					D	stA	S														
SrcISD					S	rcA	S														
DstHostA	ddr (2, 4, 10	6 by	tes)																		
SrcHostA	ddr (2, 4, 10					Pa	dd	ing	(op	ion	al)										
Info field	8 bytes)																				
Hop field	(8 bytes)							Ν	lu	mk	ber	· 0	f٢	Чо	p-	-F	ie	ld	S		
		-					7				١	/ai	ria	bl	e						
Hop field	(8 bytes)					Ζ															
Info field	8 bytes)																				
Hop field	(8 bytes)																				
	k																				
Hop field	(8 bytes)																				
Info field	8 bytes)																				
	K																				



## **Questions?**

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



Volg ons

NI SIDN.nl
@SIDN
In SIDN

### Thanks for your attention! www.sidnlabs.nl | stats.sidnlabs.nl

Joeri de Ruiter: joeri.deruiter@sidn.nl and Victor Reijs, victor.reijs@sidn.nl

